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THE FURLOUGH WANDERINGS OF A DIRECTOR OF AGRICULTURE.

By J. MACKENNA, M.A., I.C.S.,

Director of Agriculture, Burma.

INTRODUCTORY.

IN 1905 when it was decided that a separate Department of Agriculture should be established in Burma, as in the other Provinces of India, the Local Government very considerately acceded to my proposal that I should take a year's furlough to make myself familiar with what was being done in scientific agriculture in Egypt, Great Britain and Germany. In this and the following articles I propose to record, in the hope that they may interest some readers of the Journal, the impressions formed during my "Wander jahr." These notes pretend to no great scientific accuracy, nor are they to be considered as scientific studies; they are intended to convey merely an idea of the equipment, and of the class of work which is being done at the better known research institutions in Great Britain and Germany. They are based on notes made at the time of my visit and on the various reports which were kindly given to me by the officers in charge of the different places visited. These reports are, for the most part, available to the general public; but my rambling notes may take their place for those who cannot easily have access to the published literature.

In the course of my wanderings, I saw many men and many places. It is, therefore, a matter of some difficulty to decide on a starting point for these wandering notes. The memory of Ghizeh, under the shadow of the mighty Pyramids and hard by the Sphynx "more wondrous and more awful than all else in

the land of Egypt," thrusts itself forward as deserving special prominence. The magnificent laboratories and institutes of Leipsic struggle for prominent recognition. The modest retreats of Kellner at Mockern and of Wagner at Darmstadt—world-famous both—these too stand out in bold relief. But when we have surveyed all with equal mind and given all their due meed of recognition, we feel that we can, with justice to our true feelings and without impartiality, fairly find our starting point in our own country; and so it is with Rothamsted that I shall start this series of rambles.

Rothamsted.

In the village of Harpenden, and some 25 miles north of London, on the Midland Railway, is situated the world-famous Rothamsted Experimental Station. As the pious Mahomedan turns his thoughts to Mecca, so should the devout student of agricultural science, as he travels from London to Scotland (whence most of them hail), turn devoutly to the west as he speeds through Harpenden—for there is the Mecca of English scientific agriculture.

Rothamsted is not a thing of yesterday. It is 74 years since, in 1834, Sir John Bennet Lawes entered on occupation of the ancestral estate of Rothamsted, which he was to make world-famous as the centre of chemico-agricultural research. At Eton and Oxford he favoured the scientific side, and when he entered on his career as an agriculturist on the home farm at Rothamsted, he gave full rein to his natural inclinations and tastes. A chemical laboratory, fitted up in one of the best bed-rooms of the mansion house, was one of his first innovations; and the results of the quiet research here conducted, into the nutrition of plants, supplemented by pot and field experiments, were such that, in 1842, he determined to take out a patent for "Superphosphate." By this act he ranks practically as the pioneer of chemical manures. The result of this patent was not only a vast benefit to agriculture in general, but the commercial success of the discovery laid the foundations of a great fortune. In 1872 he sold his

manure business for the large sum of £300,000. Meanwhile, side by side with the commercial development, experimental research had been continuous on the Rothamsted farm, and any proved result was at once made available for the general body of agriculturists. Not only did his great researches bring him great riches but they earned also the gratitude of the farmers, whom they specially benefited. In 1853, a testimonial, practically national in its extent, was subscribed for, and, at Mr. Lawes' request, the greater portion of it was devoted to the construction of a new laboratory. Rothamsted is thus a monument, not only to its great workers but to the intelligent and reciprocal appreciation of the English farmer.

Other honours crowded upon him. The Sovereign showed Her appreciation of his work by conferring a Baronetcy upon him in 1882. France, Germany and Russia vied in doing him honour. The Universities of Oxford, Cambridge and Edinburgh all conferred upon him honorary degrees. Nearly every Scientific Society of any standing, either in England or on the continent, acknowledged in a tangible form its appreciation. The jubilee day of the Rothamsted experiments—July 29th, 1893—was a great day for Sir John Lawes and his famous colleague, Sir Henry Gilbert. The world of science—from members of the Royal Family to the smallest farmer—paid tribute to these great benefactors to agriculture. At last, in the 86th year of his age, and after a life of exceptional strenuousness which only his giant constitution could have withstood, he was gathered to his fathers. He lies buried at Harpenden, in the midst of the scenes of his life's work—leaving behind him a name which will never be forgotten in the annals of scientific agriculture.

One of the most delightful features of the relations of this charming personality with the general body of agriculturists was the reciprocity of feeling. If the agriculturist appreciated the experimental work being done at Rothamsted, Sir John was not behind in reciprocating this good feeling. He was absolutely magnanimous in his devotion to the simple toiler in the fields and splendid in his liberality. He early conceived the idea of

perpetuating the work by putting Rothamsted on a permanent footing. In 1889 he accordingly transferred the experimental fields and laboratory to a Committee, together with an endowment of £100,000. This strong and representative Committee—four nominated by the Royal Society, two by the Royal Agricultural Society, one each by the Linnean and Chemical Societies with the owner of Rothamsted,—form the Lawes' Agricultural Trust, who now control the Research Station.

The name of Sir Joseph Henry Gilbert ranks second only to that of Lawes. After a long training in Chemistry in London, Glasgow and Gniessen, he became, in 1843, the colleague of Sir John Lawes at Rothamsted—a colleague-ship which was only dissolved by the death of Sir John Lawes in 1900. This long partnership was happily referred to by Sir John Lawes at the Jubilee Celebrations at Rothamsted. He said, "When two people were joined together in marriage they could not part, because they were bound together by very solemn ties. But with regard to himself and Dr. Gilbert the case was quite different. Dr. Gilbert could have left him or he could have left Dr. Gilbert. Their connection, however, had lasted for more than fifty years. What was the cause? Nothing less than mutual love of the work they had been engaged in. He (Sir John) had delighted in the work from the beginning. All the time he could spare in the midst of many other responsibilities and duties he had given to the work. But with Dr. Gilbert it had been the work of his life. If it had not been for Dr. Gilbert's collaboration, their investigations would have been in a very different state to what they were then."

The partnership of these two famous men lasted for the long period of 57 years; nor would it appear to have been marred by the slightest friction. Their collaboration was perfect. The details of every experiment were worked out together and each worker was responsible for his own part of it; Sir John Lawes for the agricultural side; Sir Joseph Gilbert for the laboratory. Hence the excellence of the joint work. Like his distinguished colleague, Sir Joseph Gilbert had many academic and other

distinctions conferred upon him. He survived Sir John Lawes by only 16 months, dying at Harpenden on December 23rd, 1901, in his 85th year. "In death they were not divided." And so ended the greatest scientific combination that the world has, probably, ever seen.

The present Director is Mr. A. D. Hall, M.A. (Oxon.), and the Chemist, Dr. N. H. J. Miller, who has been connected with Rothamsted since 1887. Since my visit the staff has, I understand, been strengthened by the addition of Dr. E. J. Russell, the distinguished Chemist, formerly of Wye, whose work on soils is well known. All have already turned out a considerable quantity of work which ranks high in the estimation of scientific men. Mr. Hall has laid all agriculturists under obligation to him by his lucid account of the work at Rothamsted as recorded in "The Book of the Rothamsted Experiments." This should be owned and read by every one who wishes to acquaint himself with the wonderful work accomplished by Lawes and Gilbert. I have thought it advisable to give these biographical details because no one can think of Rothamsted without calling up the memory of Lawes and Gilbert. They were the apostles of English scientific agriculture, and the mention of Rothamsted must inevitably suggest their names.

In studying the Rothamsted field work, it should be noted that the object of these long-continued experiments is to discover "how a plant grows" and only indirectly to find the most paying method and manuring. What is aimed at is the discovery of general principles; to obtain knowledge that is true everywhere; research in the truest sense of the word; the application being adapted in particular cases to the peculiar conditions of the soil or crop being dealt with.

Before proceeding to an enumeration of the field experiments and to the indication of the more interesting results, there are one or two general matters which may be touched on.

In the first place Rothamsted does not fulfil the usually accepted idea of an experimental farm, *i.e.*, a homogeneous connected block divided into separate fields. Rothamsted is a

composite station consisting of odd fields taken out of the estate to suit the conditions required by its illustrious donor. There is nothing of the "ringed fence" about it. Hard by the central Laboratory and other buildings are two fields (Agdell and Barnfield), which are in the experimental area. These fall to the east of the mansion house of Rothamsted. To the south-west lies a grass park where experiments are also carried out, while three of the principal fields—Broadbalk, Hoos field and Little Hoos field, lie slightly to the north-west of the mansion house. The experimental area is thus limited to a small range of six fields, with a total area of about 37 acres. In choosing his areas for experiments, Sir John Lawes did not worry much about the disintegration of the estate which resulted when he donated these experimental plots to the Trust. But he emphasised clearly the absolute necessity for uniformity of soil, a point which is of the greatest importance when one is planning experimental work, and one which should not be lost sight of in India, even if, to obtain it, one must give the experimental area a rather patchwork appearance. Another point which will be of interest to Indian readers is the description of the Rothamsted soils. Writing of it in 1847 Lawes said: "The soil upon which my experiments were tried consists of rather a heavy loam, resting upon chalk, capable of producing good wheat when well manured." Mr. Hall remarks that it is fairly uniform in the different fields and consists essentially of a heavy loam containing little coarse sand or grit, but a considerable amount of fine sand and silt and a large body of clay. In consequence the soil has to be worked with care, and if tilled when wet it dries into impracticable clods. It "runs together" if heavy rain falls after a tilth has been established and then dries with a hard unkindly surface, these difficulties being much exaggerated on the plots which have been farmed for a long time without any supply of organic matter in the manures.

Mr. Hall might be writing of many parts of India. To how many of us are lands such as he describes an absolute

heart-break ? But it is encouraging to learn that the addition of organic manures helps to bring the land into good condition and with farmyard and green manuring we can manage this in most parts of India.

The ordinary meteorological observations are taken with great accuracy at Rothamsted. I should not mention them here were it not that any one who visits Nawabganj, near Cawnpore, can see a copy there of the appliances used at Rothamsted for measuring the amount of water percolating through bare soil. Briefly described, these experiments are carried out by means of drain-gauges,* with an area of 1/1000th of an acre. The soil is undermined at different depths—20, 40 and 60 inches, and the soil thus sectioned off is supported by perforated iron plates. Trenches are then cut round these sections of soil and the sections are isolated by brick or cement walls. The external soil is put back. The water percolates through the sectional block into zinc funnels from which it passes to the measuring cylinders.

The general impression at Cawnpore was that, experiments of this kind need hardly be undertaken generally in India ; but the Cawnpore series will give an idea of what is done at Rothamsted.

Of the six experimental fields belonging to the Lawes Agricultural Trust, some have greater interest than others for an Indian agriculturist. For instance, the rotation experiments of the Agdell fields, being based on crops like swedes and clover, which are practically unknown in India, give no direct results that would appeal to agriculturists out here. But the scheme of the experiments may give helpful suggestions. The order of the rotation is :—

1st year : Swedes.
2nd year : Barley.
3rd year : Clover (or beans) or fallow.
4th year : Wheat.

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* An illustrated description of such gauges will be found in the Memoirs of the Dept. Chem. Series, Vol. I, No. 4.

As regards manuring the scheme is :—

1. No manure.
2. Mineral manure only (*i.e.*, without nitrogen).
3. A complete manure.

The manures are applied only to the first crop of the rotation —the swedes—the remaining crops of the rotation getting the residual value of the manures only. These experiments began in 1848.

Without examining all the details of this scheme there are one or two obvious points which suggest themselves as of interest. What, in this system of continuous cropping, will be the effect of no manures on the various crops of the rotation, and what is the effect on the succeeding crops of the rotation by the introduction in the 3rd year of a leguminous crop—clover or beans—instead of a bare fallow ?

With regard to the first point, the only crop that is not seriously affected is the deep-rooted wheat crop. In the 56th year, without any manure, it yielded no less than 19·6 bushels per acre. Swedes, practically surface feeders, do worst of all and clover and barley are small crops also. In the second course, *i.e.*, mineral manures without nitrogen—the crops of the rotation do just about as well as they do on the unmanured plot ; but the clover—which is leguminous and fixes its own nitrogen—produces almost as much as on the fully manured field, yielding in the latter case 37·8 cwt. of hay as against 35·5 cwt. when a mineral manure without nitrogen is applied.

The effect of the leguminous crops is all in favour of clover ; but the obvious fact is also clearly emphasised that the benefit from a leguminous crop on a subsequent crop depends greatly on the vitality and quality of the leguminous crop. On the unmanured plots where the clover crop averages only 15·2 cwt., there is a loss in wheat in comparison with a crop following bare fallow of 16·7 per cent. This is doubtless because on the unmanured plot the growth of clover is too small to leave behind any residue of nitrogen. It is also noted that after a good crop of clover the beneficial effect is obvious throughout the whole rotation.

On the contrary, the introduction of beans into the rotation seems to confer no benefit at all. In every case, wheat following beans shows a percentage of decrease in comparison with the outturn after a bare fallow. This is probably due to the habit of the bran crop, though it also indicates that the question of the exact effect of the different legumes on soils is still an undecided one.

From Agdell we pass into Barn field, but the crop here is Mangel Wurzel—a crop that does not interest India much, though a great fodder staple in the south of England. So we may pass the elaborate manurial experiments on this crop and move on to the Park, close to the mansion house of Rothamsted, a block of some seven acres which contains probably the most remarkable series of experiments on grass in Great Britain.

The series of experiments started in 1856, but the Park has been under grass from time immemorial. There is no record of any seed having ever been sown; but when the experiments commenced, the herbage was fairly uniform.

The Park has been divided into 20 sections, to which an elaborate system of manuring has been applied. The produce of these plots is separately weighed whenever it is cut for hay—usually twice a year—and a botanical analysis is also made to ascertain the effects of the different manures on the composition of the herbage.

The results may be summarised briefly as follows:—

On the unmanured plots there is no sign of exhaustion as determined by the yield, but a rankness of the herbage is apparent. The proportion of weeds increases every year and now amounts to almost half the herbage. Quaking grass is about 20 per cent. of the herbage and Sheep's Fescue, Bird's Foot Trefoil, Burnet Hawk Bit and Black Knapweed are very common.

When nitrogenous manures alone are used, it has been found that nitrate of soda is the best manure to use as it encourages the growth of deep-rooted grasses, like Meadow Foxtail, etc. Ammonium salts, used alone, were found to cause sourness in the

land while nitrate of soda produced a more varied herbage than ammonium salts.

In the case of mineral manures used alone, when a complete mineral manure was applied, plots showed no signs of declining fertility. Nitrogen seemed to be supplied by the leguminous weeds which formed 24 per cent. of the herbage. The predominant legume was *Lathyrus pracensis*, red and white clover were also present together with a large number of grasses and, amongst the weeds, Yarrow and Sorrel are abundant.

When potash is omitted, the plots show poor results and there is a great poverty of leguminous herbage—there being only about half as much as on the plot getting a complete mineral manure. The characteristic legume under this treatment is Bird's Foot Trefoil and the characteristic weeds are the Butter Cup, Black Knapweed Plantain and Yarrow.

When superphosphate alone is applied, the result is a very impoverished appearance and an outturn little more than that from unmanured plots. Quaking grass predominates and, amongst the weeds, Hawk Bit Burnet and Plantain. The presence of these weeds and inferior grasses seems to indicate that these plots are more exhausted than the unmanured ones. The results show the disastrous effects of long-continued one-sided manuring.

The final group is the application of complete manures—minerals plus nitrogen. In the application of these, the quantities of the mineral manures and their relative ratios remain the same on all plots, but the quantities of nitrogen vary from plot to plot.

The heaviest yield of all the plots was obtained from a complete mineral manure, containing both phosphoric acid and potash, plus 129 lbs. of ammonium salts to the acre. But, while greatest in quantity, excessive use of nitrogenous manures on this plot causes the herbage to become very coarse; consisting as it did, of Coarse Meadow Foxtail, Yorkshire Fog and Tall Oat Grass. The soil of this plot has also become sour and unhealthy and leguminous herbage has been killed out. The results seem to prove that nitrate of soda in combination with minerals acts

better than ammonium sulphate. They also show that mineral manuring always increases the leguminous herbage. The best result of all the plots is probably obtained from a plot which receives a complete mineral manure, plus nitrate of soda 43 lbs. of nitrogen per acre. This quantity probably marks the limit of profitable manuring with nitrate of soda.

It may safely be said, without fear of contradiction, that the Broadbalk field on which the wheat experiments are carried out is the most famous experimental plot in the world. Here, since 1843, experiments on the continuous growth of wheat have been carried out, and, since 1852 the scheme of manurial treatment has been constant. But in this series, the particular plot that stands out conspicuously is the unmanured plot which, laid down in 1843, and having been previously unmanured for four years—now in its 70th year of continuous wheat cultivation—has given for the last four years an average outturn of some 12½ to 13 bushels per acre, which is the average output of the wheat area of the world. There have been fluctuations, *e.g.*, in 1906 the plot yielded at the rate of 18 bushels per acre; but these fluctuations have always been attributable to the condition of the seasons. So far as can be judged, there is no indication of a likely decrease in outturn, and the reason for this apparently constant return is a question, which, while of extreme scientific interest, has not yet been satisfactorily explained.

The other plots are treated with farmyard manure, minerals, single, double and treble ammonium salts, plus minerals, single nitrate and mineral, rape cake and so on. To discuss the results in detail would be outside the province of this article so that only a brief outline will be given. In the plot which received farmyard manure calculated to supply, on an average, 200 lbs. of nitrogen, 78 lbs. of phosphoric acid, and 235 lbs. of potash, a rapid rise in fertility was noticeable for the first years, due to the original exhaustion of the land. This was followed by a decline during the decade, 1872-81, but since then the yield of grain has again rapidly risen. Of the reserves left on the plot, it has been calculated from other experiments at Rothamsted

that, even in fifty years, it will be impossible to crop them out. In the plots which received artificial manures which supply nitrogen, potash and phosphoric acid without the addition of any organic matter to form humus, the plot which received double ammonium salts and minerals came very near in yield to the farmyard manure plot and as yet shows no decline in fertility. In the plot which received single ammonium salts and minerals the supply of nitrogen proved insufficient and a decline of fertility is evident for a time, although, as in the case of the unmanured plot, a fairly constant yield for subsequent years has been got. In the plot which received nitrogen only in the shape of an annual dressing of 400 lbs. of ammonium salts the crop yields were well maintained, but the crops present an unhealthy appearance, were slow to mature, and liable to rust.

The important conclusion to be drawn from the experiments is that wheat, with judicious manuring, although grown year after year in the same land, can be made to produce as paying crops as when grown in rotation in the ordinary way.

One of the most interesting results of these continuous wheat experiments is the determination of the fate of the principal manurial constituents. Of about 10,000 lbs. of nitrogen supplied as dung during the whole period only about 2,600 lbs. have been recovered in the crop (about 26%) and of the remainder, after analysis of the soil, 5,670 lbs. cannot be accounted for. It has probably been washed away as nitrate into the drains or converted into free nitrogen gas by bacterial action. In connection with phosphoric acid and potash it is interesting to note that Dr. Dyer's analysis shows that of the surplus one ought to expect, after deduction of the amounts taken off by the crops, the greater part of this excess was found in the top 9 inches of the soil, and in a form readily available for plant food. These results have been of far-reaching importance as contribution towards general agricultural theory.

In the Hoos field we have a number of experiments. The principal series is that on the continuous growth of barley. This crop is only of importance in the north of India, so that it is

not important to give a detailed account of the various results. But it may be remarked that, so far as gross outturn is concerned, the best results would appear to be obtained from farmyard manure at the rate of 14 tons to the acre. Results also show that the decline in production on land continuously cultivated with barley and without any manure is much more rapid than in the case of continuous wheat.

In this field an attempt has also been made to grow leguminous crops continuously since 1848. Despite various schemes of manuring, the crops as a rule have been very small, and in some cases have failed completely. In 1898 a portion of these plots was ploughed up and 5 crops of wheat taken oft without manure to test the amount of nitrogen accumulated by the leguminous crops and left in the soil. Various experiments of a similar kind with leguminous crops are still being carried on in this field, a halt in the old series having been called in 1903, by fallowing to clear the land and the new series originating with 1904.

In this field there is also an interesting series of experiments on the residual value of manures. For 26 years potatoes were grown on various plots with different manures. It may incidentally be remarked that, from the outturns, Rothamsted compares badly, as potato land, with the west coast of Ayrshire or the Lothians, 5 tons per acre being apparently the best it can do under any form of manuring. In 1902 no manure was applied and barley was sown in that year and in 1903, and Black Tartarian Oats in 1904. The experiment shows that the residue is very rapidly exhausted; for instance, when farmyard manure at the rate of 14 tons per acre had been applied to the potato crop from 1883 to 1901 with a previous manuring of superphosphate from 1876 to 1883, the average produce of total tubers per acre during that period (1876 to 1901 inclusive) was 4·8 tons. In 1902, when a barley crop was taken without any manure, the yield was 71 bushels of dressed grain and 5,216 lbs. of straw, and when this was followed by a second barley crop without manure in 1903, the yield declined to 46·9 bushels of dressed

grain and 3,474 lbs. of straw. A subsequent crop of oats in 1904, again without manure, yielded 55·5 bushels of grain and 3,060 lbs. of straw. In 1906 barley had fallen to 36 bushels per acre. The rapid decline in barley is striking, but the series of experiments hardly as yet admits of accurate deductions.

At Rothamsted, as at most experimental stations, trials have been made with the various media for inoculating leguminous crops. The crops subjected to the various processes are red clover and the cow-pea (*Vigna catiang*), and the method of the experiment is as follows : In one plot the soil is inoculated with Hiltner's preparation ; in the second Moore's preparation is applied. The third plot contains soil from a field which had carried red clover in 1904, and the fourth plot is left uninoculated. No definite conclusions had been reached when I visited Rothamsted, but the mean of the first two crops indicates the slight superiority of Hiltner's preparation over the other inoculations, while all show an advantage over the uninoculated plot.

Another interesting series of experiments in this field is the effect of bare fallow on wheat, a comparison being instituted with the continuous unmatured wheat plot in the Broadbalk field. In this way it is possible to deduce the value of the bare fallow which over a period of 56 years has been very marked in favour of wheat after fallow.

The last experimental plot on the estate is the Little Hoos field and, in many ways, it is not the least interesting of the series. The principle underlying the experiments in this field is the testing of the residual value of certain typical manures, *i.e.*, the value of the residues left in the soil after one or more crops have been grown since the time of their application. To eliminate the effect of season, the result yielded by the residue is, in all cases, compared with that of a new application of the same manure, as well as with a continuously unmanured check plot. The experiment is on a four years' rotation of swedes, barley, mangels and oats and the residual value of the manures is tested thus up to the fourth year after application. In many respects, this is one of the most interesting series of experiments at

Rothamsted and has an economic bearing on the valuation of improvements to land when arbitration questions arise.

The impression which must be left on the mind after a consideration of the work that is being done at Rothamsted is the largeness of conception, which framed these lines of investigation. "Continuity" is the keynote of the work at Rothamsted. It was illustrated in the long association of Lawes and Gilbert: it is the principle running through all the experiments. There was something grand in the conception of the lines of work; a confidence that defied the limitations of nature and that was inspired with an intuitional assurance that lines of research were being originated which other workers would continue and posterity would not willingly let die. Their outlook was large; they worked not for the present that was with them but for the future that was to be. The result has been a series of experiments which is quite unique in the history of scientific agriculture and which might well by this time adopt the mantle of hoary-headed age. But it is a robust and vigorous old age. There are no traces of senile decay.

(To be continued.)

EXPERIMENTAL WORK ON FIBRES IN INDIA

By R. S. FINLOW, B.Sc., F.C.S.,

Fibre Expert to the Government of Eastern Bengal and Assam.

THE work of the past year under this heading includes :—

Lines of work in 1907-08.

(*a*) Jute experiments carried out by the Agricultural Departments of Bengal and Eastern Bengal and Assam, with the object of improving the crop, both as regards the yield and quality of fibre.

(*b*) Experimental trials in other Provinces of India in pursuance of the scheme to extend the cultivation of jute outside Bengal and Assam.

(*c*) An investigation into the deterioration of baled jute by the Fibre Expert to the Government of Eastern Bengal and Assam in collaboration with Messrs. Cross and Bevan, of London.

(*d*) Continuation of experimental work with flax and other fibres.

(*e*) The report of a Sub-Committee of the Board of Agriculture on the cultivation of fibre plants in India and the probable effect of extending such cultivation.

Bengal. Experiments with jute. Burdwan.

The jute experiments conducted by the Bengal Agricultural Department at the Burdwan Farm since 1904 are now regarded as having definitely proved, for the Burdwan District, that

(1) Farmyard manure (70 maunds) or castor cake ($7\frac{1}{2}$ maunds) per acre are the best and most economical manures.

(2) The crop should be sown about the third week in April on a thoroughly prepared seed bed.

(3) The plants should be thinned out to 4 inches apart.

(4) The yield of fibre increases with the age of the crop; but the stage at which the heaviest yield of fibre of the best quality is obtained is when the fruits have fully set.

(5) Any one of ten races of jute recommended may be grown.

A series of quantitative experiments have been carried out, showing the profitable nature of a rotation of jute and paddy or of jute and potatoes (the latter crop irrigated).

Cuttack.

The results of experiments at Cuttack have proved that jute grows well in parts of the Orissa Division, in rotation with paddy or potatoes if proper attention is paid to the manuring of the crop.

Experiments by the Eastern Bengal Department.

In collaboration with the Reporter on Economic Products to the Government of India, an extensive study is being made of the races of jute in Bengal and Eastern Bengal. A tentative account of the conclusions so far arrived at is contained in Agricultural Ledger No. 6 of 1907. So far it has been found possible to reduce the number of so-called races of *C. capsularis* from over one hundred to thirty-three, and of this residue there are many which are only being kept apart pending further observation. The tendency is, in fact, for the races to classify themselves under four main heads, *viz.*:—

Red stemmed races	which mature	early.
Do.	do.	late.
Green stemmed	do.	early.
Do.	do.	late.

Chemical and microscopical examination of the fibres.

A partial chemical and microscopical examination of the respective fibres of the various races shows great similarity in their composition and structure, thus supporting the field observations. There is, nevertheless, no doubt that the distinctions as regards quality—largely geographical—recognised in the jute tracts are genuine and, in view of this, a series of experiments has been devised to ascertain the effect of soil, climate and especially of the retting water on the quality of fibre produced.

Effect of soil, climate and retting water on quality of fibre.

As a result of preliminary selection, one or two races are now regarded as pure, and cross-fertilisation experiments have been commenced this season (1908). It remains for time to show whether any great improvement will be brought about by this means. In view of the comparatively slight differences which exist between the various races, it is hardly to be expected that such advantages will accrue in the case of jute as have been brought about by cross-fertilisation work with other crops. The experiments will, however, in any case, render clear many points which are now obscure.

Cross-breeding experiments.

With the object of inducing the *ryots* in the Chittagong District to grow jute as a field crop for export, instead of on a garden scale for home use, a special grant of money was made by the Government of Eastern Bengal and Assam for a series of demonstrations in three typical tracts. The demonstrations which have been carried out by cultivators from Dacca and, as far as possible, without direct departmental interference are, in one sense, an experiment to ascertain whether proved results can be brought to the *ryot's* notice in an informal way through the agency of men of his own class.

Demonstration of jute cultivation in Chittagong.

Jute experiments in other Provinces.

Experiments with the object of introducing jute cultivation continue to be made in—

(*a*) The Bombay Presidency,
(*b*) The Central Provinces,
(*c*) The Madras Presidency, and
(*d*) The Punjab.

Bombay.

At Ganeshkhind, near Poona, progress was made last season (1907), in that one plot yielded a profit for the first time, after deducting all expenses. This year's crop (1908) is still more hopeful, especially as experience in dealing with it is enabling cultivation expenses to be reduced.

Central Provinces.

Trials in 1907 at Nagpur and Raipur under irrigation were successful. The yield at Nagpur was at the rate of $18\frac{1}{4}$ mds. per acre and the fibre was valued at Rs. 6 per md., representing a gross return of Rs. 112

per acre. Jute was sown on two demonstration farms this year: but the crops have been adversely affected by the unfavourable weather in the early part of the season. Nevertheless, a very fine crop has been grown at Telinkheri near Nagpur, the yield of which is estimated at over 20 mds. per acre. It is now recognised by the Central Provinces Agricultural Department that jute is capable of becoming a useful rotation crop in the Provinces, and steps are being taken to bring facts connected with successful cultivation to the notice of the *ryot*.

Madras.

Trials are being continued this year (1908) in the Godaveri and Cauveri Deltas and on the Malabar Coast. At Tanjore in the Cauveri Delta, the plots are not so good as on the Malabar Coast where the climate is not unlike that of Bengal and where one crop grew 9 feet high in two months. Seed for over 20 acres was sent for experimental cultivation to Madras this season, and the Agricultural Department is making an attempt to create a local market for the fibre produced.

Punjab.

Owing to a severe attack of caterpillars, the plots at Lyallpur this year are not the success they were in 1907 when an average yield of 11 mds. of fibre per acre was obtained, the return from some of the plots being much higher. The cultivators in the Chenab Colony are very enterprising, but their wheat and oilseed crops which they grow chiefly for export are very profitable in average years, and it is doubtful whether Jute cultivation will be taken up seriously in the Colony or any part of the Punjab. In the event of an extension of such cultivation, special tanks filled with water from the canal system would be necessary for retting. These tanks could be cheaply constructed, but for general cultivation and for preparation for market the cost of labour would be excessive as compared with other parts of India.

Burma

At present Jute is only grown by the jails where the fibre is made up into bags and rough mats; but experiments are in progress in some districts where it is anticipated the crop may thrive. The lack of suffi-

cient labour is likely to be a serious difficulty in the way of development.

Distribution of seed.

The Agricultural Departments of Bengal and Eastern Bengal are both engaged in the production and distribution of good jute seed of guaranteed quality.

The deterioration of baled jute.

After baling, some jute undergoes, sometimes in the course of a few weeks, a deterioration known as "heart damage," whereby the whole nature of the fibre is changed. The chief characteristic of the deterioration is an entire loss of tensile strength, the fibre becoming so brittle as to be capable of being rubbed into a fine powder. Three per cent. of the imports into Dundee in 1906 are said to have been rejected on account of "heart damage." The Agricultural Department in Eastern Bengal and Assam arranged to collaborate with Messrs. Cross and Bevan, of London, who afterwards obtained a grant of money from the Secretary of State for India, in an investigation into the causes and possible means of prevention of the deterioration. Messrs. Cross and Bevan have presented a report to the India Office, based on the results of their examination of a number of bales of jute, specially treated in India, by the Eastern Bengal Department before export to London. The jute in all the bales was watered and the contents of some bales were treated with antiseptics, but in no case was there, on arrival, any sign of "heart damage." The presence of nearly 30 per cent. of water in the baled fibre, which was of first class quality, did not cause evident damage to the bales which were sent as an experiment. Bacteriological examination of the contents of the bales showed that the fibre treated with antiseptics (formalin and corrosive sublimate) was nearly sterile on arrival, and Messrs. Cross and Bevan draw the conclusion that the presence of formalin would prevent the occurrence of "heart damage." Although this conjecture may possibly be correct, it still remains to be proved; it is hardly a justifiable deduction, from the evidence available. Meanwhile, in experiments at Pusa, "heart damage" has been produced under well-defined conditions,

and it is hoped that definite results will be obtained in the near future from the work in India.

Flax in Behar.

Experiments with this crop in Behar have made considerable progress. During the cold weather of 1907, a large area (over 100 acres) was grown at Dooriah under the supervision of Mr. Vanderkerkhove, a practical Flax Farmer from Belgium, engaged by the Government of Bengal. Mr. Vanderkerkhove also gave advice on the experimental cultivation of this crop at Pusa. The results obtained are very satisfactory, the straw produced being far better, both in quantity and quality, than in the previous year. The experiments indicate that in an ordinary season in Behar, flax is likely to yield a handsome profit, which is estimated at Rs. 74 per acre. Mr. Vanderkerkhove has issued a report, an exhaustive summary of which, by the Inspector-General of Agriculture, appeared in the *Agricultural Journal of India*, Vol. III, Part 2, April 1907. Mr. Vanderkerkhove has been engaged for a further term of five years in order that he may assist in the thorough working out of questions germane to the new industry, such as the comparison of indigenous and exotic varieties of flax, the selection of proper lands, manures, rotations and retting methods.

Flax in Eastern Bengal and Assam.

Experimental cultivation of flax last season (1907) at Dacca and in Cachar produced sufficiently good results to warrant extended trials, which were arranged for this year in Assam. Other conditions being equal, the absence of lime in the retting water would probably enable Assam to produce a higher grade of fibre than Behar. An illustrated Bulletin, dealing specially with the prospects of flax in Eastern Bengal and Assam, is about to be issued.

Bombay and Kashmir.

Arrangements have also been made for experiments with flax this season in Bombay and in Kashmir.

Other fibre plants.

A general investigation of Indian fibre-yielding plants has been commenced, and is being carried out not only with regard to the intrinsic value of the fibre of each, but with reference also to the agricultural

possibilities of those plants which are usually cultivated or which grow naturally in forests or on waste or other places.

Report of the Sub-Committee of the Board of Agriculture.

This Committee arrived at the following conclusions :—

(*a*) That a large and profitable extension of jute cultivation is possible and probable in Assam, and that owing to the fact that the cultivation of jute does not prevent the raising of paddy or rabi food crop in the same year, such an extension would not menace the food-supply of the cultivators.

(*b*) That experimental trials have justified the belief that jute may be profitably cultivated in parts of the Central Provinces, Bombay and Madras.

(*c*) That difficulties regarding retting water in the Punjab and labour in Burma will probably militate against successful jute cultivation in these Provinces.

(*d*) That a considerable and advantageous extension of Sann-hemp cultivation might take place in the Central Provinces and in Madras, and that the growing of *Hibiscus cannabinus* (a jute substitute) might be encouraged in tracts whose climatic conditions are not suitable for jute.

(*e*) That extensive trials have proved the possibility of a successful flax industry in Behar and that the prospects of extending the cultivation of this fibre crop to other tracts should be investigated.

(*f*) That a considerable increase of Agave cultivation by capitalists is possible in Assam; but that the chances of its success in drier climates still remain to be proved.

(*g*) Rhea has failed in Behar, which is too dry, and its successful cultivation is likely to be limited to a comparatively narrow zone, where both climate and soil are particularly suitable. Neither agave nor rhea are likely to be taken up on a large scale by cultivators in the near future.

(*h*) Bearing in mind the importance of not allowing non-food crops to encroach on the area necessary for the food supply, fibre

crops which only occupy the land for one season are generally to be preferred to those of a perennial nature.

(*i*) That no such diminution of prices is likely as would render the cultivation of fibre crops unprofitable.

SOME INDIRECT BENEFITS OF IRRIGATION NOT GENERALLY RECOGNIZED.

By HENRY MARSH, C.I.E., M.INST.C.E.,

Consulting Engineer, Protective Irrigation Works, Central India.

MANY people think that Irrigation from canals, wells, and tanks is only of use as a protective agent in tracts of precarious or slight rainfall. They know, of course, that millions of acres have been reclaimed from desert by the harnessing of rivers in the Punjab, in Sindh, and in Egypt. But they are probably not aware of the many indirect benefits which accrue to the State and agriculture from the presence of unfailing irrigation even when the rainfall is fair to good. In this article it is proposed to deal with the advantages which are thus derived, and though not patent to the public, are well known to revenue officers in Upper India.

2. Before going into details, it is well to summarise these unconsidered assets as follows :—

(*a*) Power of substituting immediate sowings in case of destruction to advanced crops, or harvests.

(*b*) Diversity of cropping, *i.e.*, insurance against losses.

(*c*) Maintenance of cultivation, and demand for labour throughout the season.

(*d*) Presence of fodder, pasturage, and water for cattle.

(*e*) Improved sanitary conditions.

(*f*) General increase of comfort, well-being, and decrease of crime.

Power of substituting new sowings in case of accidents to advanced crops or harvests.

3. The last two decades have afforded many melancholy opportunities of observing injuries to crops, which were giving splendid promise of bumper harvests. In 1904-05 the autumn sowings had been unusually extensive, and the winter rains had benefited

them to such an extent that prospects were exceptionally good. However, three or four days of extraordinary frost in the beginning of February 1905 completely changed these happy conditions. All advanced crops were utterly ruined, and where the peasants had no irrigation to water the fields, their plight was very serious. They simply had nothing to look forward to, until the following monsoon would enable them to sow kharif grains. In Bundelkund the rain did not come at all, and thus misfortune followed misfortune. The case was, however, very different with the irrigating tenants. The ruined wheat fields were quickly ploughed into the soil, and sown with "zaid" crops, *i.e.*, "chehna" (*Panicum miliaceum*), vegetables, melons, etc. The cultivation of "chehna" proved to be a very sound enterprise, as it ripened in two months, and produced five or six maunds of grain to the acre. Other tenants got the land ready for sugar, if they had the necessary manure. Others prepared it for April sowings of maize, juar, cotton, and hot weather rice. Maize sown at this period produced cobs in July, and fetched ready money in the local markets. Early cotton plants were well advanced, when the monsoon arrived, and were therefore not liable to injury from flooding. This form of cultivation is largely replacing the indigo of the Jumna and Ganges Canals, and requires every encouragement. It enriches the land and produces a better class of fibre. Irrigation was also the cause of other benefits in this phenomenal frost calamity of February 1905. Fields that had recently taken water escaped almost entirely. I was Chief Engineer of Irrigation at the time in the United Provinces, and remember well having to run the Canals, although the executive staff wished to have them closed for urgent repairs. The water thus given had a most beneficial effect in resuscitating crops that were seemingly killed by the excessively low temperature. After a short period of, so to speak, hibernation, they recovered, and gave very fair returns. In Muzaffarnagar and Saharanpore, where frost is a common occurrence, the cultivators are constantly on the look-out for it in the winter months, and freely irrigate the young crops to prevent mischief. They attribute the protection to the

thicker and stronger growth of the irrigated plant. This idea is similar to that held by cultivators of unirrigated soils. They rejoice exceedingly when propitious rains arrive before the frosty season. Experience proves that the young rabi is much strengthened by the damp, and thus able to resist subsequent low temperatures. So far I have only dealt with the case of the calamitous frost in 1905, and have shown that the irrigating tenant was in a position to retrieve his losses by fresh sowings. But the same reasoning applies to other agricultural disasters. Hardly a year passes, in which the Gazettes do not record the devastating effects in some parts of the country from locusts, hail or rust. In the report on the famine of 1895-96-97, it is recorded that the drought of these years merely completed the agricultural ruin, caused by the excessive winter rains in 1892-93-94 In the last-named seasons immense sheets of spring crops were destroyed by blight. Lowlying lands were too wet for cultivation. Even where the wheat and barley had ripened, and had been cut, the unseasonable rain and storms damaged the grain on the threshing floors. Independent of these well-known calamities, cultivators of tracts near forests or jungles frequently find their fields eaten up in one night by a herd of Nilgai or Deer. Here, again, the case of the owners is black indeed, if they have no means of resowing crops, until the following monsoon. I have recounted all these calamities, to show how many trials beset a cultivator, and how speculative are his chances of harvest profits, unless he has the means of renewing his sowings without delay.

Insuring advantages of irrigation (*i.e.*, diversity of cropping).

4. All wise agriculturists agree in the advantage of cultivating a variety of crops, *i.e.*, "in not carrying all the eggs in one basket." The Indian peasant follows out this idea in a rough way, by sowing various mixtures, which is not always the best form of insurance, as it depreciates the market price of his grain. Thus, rice and *kodo*, gram and wheat, peas and barley are cultivated at the same time, and in the same field. There are many other combinations, but the main idea is, that dry weather will

suit one plant, and a rainy season the second; hence some measure of success may be expected. Where irrigation exists, the position of the cultivator is much sounder. Continuous and heavy rain, which is disastrous to cotton, millets, and cold weather cereals is advantageous to sugarcane and rice. Without irrigation these valuable crops are rarely attempted, except in low-lying lands. This form of insurance is very sound, and is proved by the fact, that remissions are almost unknown, where sugar-cane and rice are cultivated and irrigated. They flourish mostly in damp, cool climates, but require water to mature them. Contrary to general opinion, it is in these climates that Irrigation Projects pay best. Proof may be given, by quoting the following extract from page 87 of the Sarda Canal Project of 1903.

"Hence the annual value of a cusec is much higher in the moist doabs of the Eastern Jumna Canal than in that of the drier and hotter country, watered by the Lower Ganges Canal. For the last five years they stand thus:

VALUE OF CUSECS.

		Eastern Jumna Canal.		Lower Ganges Canal.
		Rs.		Rs.
1898-99	...	1,172	...	571
1899-00	...	1,215	...	704
1900-01	...	1,029	...	558
1901-02	...	1,187	...	636
1902-03	...	1,232	...	705

It is also urged that the revenue will not develop as rapidly as is anticipated on account of the slow progress of the Agra Canal. Here, again, it may be pointed out that the great dryness of the country watered by the latter work has been a bar to the cultivation of first class crops."

Maintenance of cultivation, and demand for labour throughout the season.

5. These results of irrigation are very important, and are well understood by Collectors who have held charge of protected and unprotected districts. In the former, they know that agricultural operations never cease throughout the year; the labourers never have a slack time and are continually ploughing, sowing, weeding, reaping, or threshing. Crime is greatly reduced, and in seasons

of drought, the demand for labour is all the greater. Examining the operations of the year, we find that in January and February, the ground is being prepared for sugar sowings, whilst the matured cane is being harvested, and the juice expressed. The rabi crop requires great attention. Weeding, watering, fencing, and keeping off marauding animals occupy a number of hands. Harvesting of the rape or mustard is carried out in February; picking the plants and expressing the oil absorb a good deal of labour. In March and April the cutting, carrying, and threshing of the rabi is in full swing, and labourers are at a premium. Much difficulty is experienced in finding hands to hoe, and tend young sugar. Moreover, the fallow land has to be irrigated for maize, cotton, juar, or hot weather rice. In May the threshing out is still often incomplete, and the young irrigated crops require much attention. In June, July, August and September, if the monsoon is good, ploughing, sowing, and weeding occupy many people; early crops of maize and rice are cut and garnered. If on the other hand the monsoon is a failure, labour is in strong request to push on irrigation for sowing food crops, and for saving standing crops. October, November and December are absorbed in sowing the rabi, in irrigating it, and in completing the kharif harvest. Thus it is easy to see that in a well-protected country, labour is in demand throughout the year, peasants have little time to indulge in lawlessness, or in following out the freebooting instincts of their ancestors. For 31 years I served on the Ganges and Jumna Canal system; and though many famines and scarcities visited Upper India during that long period, I never saw a famine, and never saw famine labourers at work. Indeed, my great difficulty was to find hands to carry out the many sanctioned projects for new canal branches and drainage works. But during the short period in which I toured in Central India, I was brought face to face with grim starvation, and aimless wandering in two seasons out of three. This is strong testimony to the policy of pushing on protective works. It is surely better to spend money in constructing canals, tanks and wells, even though a productive return is not expected

than to await famine, distress, epidemics, etc., and spend large uneconomic sums in relieving them. In the latter case the outlay is often greater, the country is pauperized, officials are overworked, and seldom do we find any permanent result arising from all the harassing trouble and strain on State resources.

Presence of fodder, pasturage, and water for cattle.

6. Those who have experienced a severe drought can hardly have forgotten the terrible mortality amongst cattle. I have seen thousands of the weary emaciated beasts, driven along the Bombay road towards Malwa in 1905 and 1906. Rain seldom fails in that country, and hence it has earned a great reputation as a place of refuge in times of famine. Similarly, in 1899-1900, I have seen large herds driven from Rajputana and the Punjab to the Ganges khadir, and the Kumaun Terai. In all these disastrous trekkings, many losses were incurred, and bones of the wretched animals, lying along the roads, were silent witnesses to the fact. Independent of these casualties, wholesale butchering was practised in some localities. At Kunch in Jalaun, thousands were disposed of in this way. The owners sold them for a trifle, and the contractors made some profit from the skins and bones. The loss to the country must have been immense, and Government was obliged to advance large sums to the cultivators. Without this assistance, ploughing in the succeeding monsoon would have been seriously affected.

Where irrigation exists, all this horror is avoided. Water is of course plentiful, and so is the straw of all the cereal crops raised by the canals. The banks of the channels afford a certain amount of grazing, whilst spring level rises high in low lands, and causes a plentiful growth of herbage. This latter point is very important. In the valleys below tanks the grass is permanent and of great value. For miles below the embankments useful streams trickle along, and are a blessing to man and beast. The rise of spring level is also of immense use in rendering well-water accessible. This matter is, however, seldom realized until a tank embankment falls into disrepair, and the commanded wells become useless.

Improved Sanitary conditions.

7. Years ago it was thought that canal irrigation must be the cause of many forms of disease, to which natives and Europeans are liable, in a tropical climate. The belief bore good fruit in one way, as Government sanctioned large sums of money for the execution of drainage works. Remedial measures in the way of reduction of excessive watering were also carried out. More branches, and more distributaries were constructed, and this wise policy acted as an effectual safeguard against useless irrigation and water-logging. Cultivators who were accustomed to deluge their fields weekly are now fortunate if their turn comes once a fortnight, or once a month in times of low volume. This is all good for the land, and for themselves. Still, one famous Sanitary Commissioner was rabid on the subject, and pressed the Local Government of the North-Western Provinces not only to close up some canals, but to desist from further extensions. When the case was referred to the Secretary and Chief Engineer for irrigation, he pleaded that canal-irrigated villages would show a better return of health than those of unirrigated villages in the same latitude. He considered this would be the case, as the inhabitants of the former were better clothed and better fed. Investigation proved that the Chief Engineer was right, and the matter was allowed to drop. Very little argument is required to show that though fever may be caused by irrigation, the sanitary advantages far outweigh the disadvantages. Natives live largely on dairy products, and it is therefore necessary that milch cattle should have good drinking-water. Without canals, streams, or large tanks this essential does not exist. The conditions in which some beasts have to quench their thirst in offensive village ponds are no doubt a danger to the public. Milch cattle have power to pass off poisonous ingredients in their milk, and thus it is easy to conclude why many outbreaks of disease take place in drought-stricken tracts. A well-known case of this kind occurred in Gloucestershire some thirty years ago, when a number of people were invalided, by consuming the milk from a certain dairy farm. Subsequent investigation proved that the bullocks and heifers on

the land were sick, and dying, whilst the cows which produced the deleterious milk were thriving. This fact gave the clue, and it was then discovered, that for the sake of salt, the beasts had been licking a keg of poisonous paint which had been left in the meadows. The cows did not suffer, as they passed off the poison in the milk; the other beasts sickened and died. Very possibly similar reasons produced the terrible scourges of cholera which used to rage in the Meerut and Agra Divisions, before canal irrigation was introduced. The memorial stones on the camping grounds, giving lists of officers and soldiers who died from the disease 40 and 50 years ago are strong proofs of this conclusion. Such epidemics seem to have quitted this highly irrigated part of the country, and it may be claimed that the immunity is due to the presence of the flowing water in the canals. Nothing is so deadly as a scarcity of potable water in a tropical country. It has been very truly said that more lives are lost in India from want of water than from want of food. There is another great advantage in the introduction of canal water from the large rivers. Wells in Muttra and Agra Districts, that used to be brackish, have now become sweet. This is a great joy to the people, who used to struggle for vessels of potable water at the few wells which were not bitter.

General improvement of the people and country.

8. In this paragraph an attempt will be made to indicate the general benefits which arise from the improved conditions already explained. The cultivators who are well placed, as regards irrigation, gradually reach a stage of assured financial stability. Though they may not obtain heavy harvests in years of drought, and though some crops may be lost by reason of various calamities, yet a portion of sowings will come to maturity, and splendid prices will be realized. In this way, the tenant clears off all debts, builds a better house for himself, keeps better cattle, and finds no trouble in marrying off his children. Altogether a better state of well-being is arrived at. Rents come in regularly, and instead of the headmen felling the mango groves, new plantations are laid out, and new wells are sunk. The population increases, the waste

lands are reclaimed, and brought under the plough. In time, villages comprising a few huts will become quite large towns connected with centres of trade by roads or railways. The advantages derived by Government are most important. The land revenue becomes stable, and advances are not required to tide the tenants over bad seasons. The people who are dacoits and cattle lifters become respectable, law-abiding members of society. Instead of spending large sums in maintaining peace, the State has to consider schemes for roads, hospitals, and schools. The increased wealth of the people leads them to make long pilgrimages, and the facilities of travelling must exercise a strong educative effect. It has been said with considerable truth that after all a railway engine is the best school master. Railways themselves benefit enormously by the prosperity of the cultivators. The exports of produce increase by leaps and bounds, and returns do not fall off in irrigated tracts, as they do in unprotected countries. India is mainly an agricultural country ; nothing is so necessary to her as the development of irrigation facilities, and prevention of the wasteful escape of river water to the seas. Not only do these protective works afford food and occupation for millions, but the climate itself is modified beneficially. Intense aridity is checked, and healthful dews are created, which assist in the growth of herbage and trees. The Monsoon rains descend on levelled fields covered with young crops, and the latter act as powerful agents in preventing denudation, and limiting excessive floods in the main rivers. Mr. Buchanan, Under Secretary of State for India, has evidently grasped the advantages of developing irrigation works, and has impressed them on the House of Commons in his recent Budget Speech. He said : "There is no sphere of work in which the Indian Government has been engaged, which is more satisfactory to contemplate than that of the railway and irrigation works." * * * * "I have given notice of a bill for renewing our power of borrowing money for railway, irrigation, and other general purposes, but I have not yet had the opportunity of introducing it. It is a measure, however, that will [illegible]ly commend itself to the approbation of the House, and

from it we may expect very excellent results will ensue. Every one will recognize also, that there is no part of our work which reflects more credit on us than the admirable irrigation work, large and small, which has been carried out in recent years. It has been a help to our revenue, tending also to mitigate the condition of the poorest people in their distress. We intend to go on in the future in pursuit of that policy."

WELLS IN THE GANGETIC ALLUVIUM.

By W. H. MORELAND, C.I.E., I.C.S.,

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It is no exaggeration to say that the first condition of the prosperity of the greater part of the Gangetic alluvial plain lies in the existence of irrigation wells. Even in ordinary seasons, most of the winter crops in this plain require irrigation for their success, and in dry seasons water becomes an absolute necessity for the maintenance of the people on the land. The system of canals constructed by the Government is admittedly an enormous asset, but (to take a recent instance) during the famine year 1907-08, the area irrigated from wells was three times that which was irrigated from canals; and while the activities of the engineers have already almost exhausted the supply of water available in the rivers which serve the United Provinces, the scope for increasing the number of wells is to all appearance still almost unlimited. It may therefore be of interest to readers in other parts of India to have a short account of what these wells are, and what are their advantages and their limitations.

The alluvium consists of a long and relatively narrow plain sloping from north and west, and the uniform surface broken by the valleys which have been carved out by the rivers since the period when geological changes brought the surface of the main alluvium about the level of flowing water. The depth of the alluvium is known to exceed a thousand feet in the central portions and throughout this depth its composition is remarkably uniform, beds of clay and sand succeeding one another with little variety. In a formation of this kind, there is naturally a fairly uniform water-table, that is to say, that where a hole

is dug to a certain depth, water will begin to percolate into it. The depth to percolation-level is determined mainly by the distance from the river valleys to which reference has just been made, and though it varies from season to season with the amount of rainfall, it maintains its relative position with substantial regularity. Figure 1, which is adapted from a paper by Colonel Clibborn, a former Principal of the Roorkee Civil Engineering College, shows diagrammatically the position of the water-table between two of the rivers in the Muzaffarnagar District, and is a fair illustration of the position in the greater part of the alluvium.

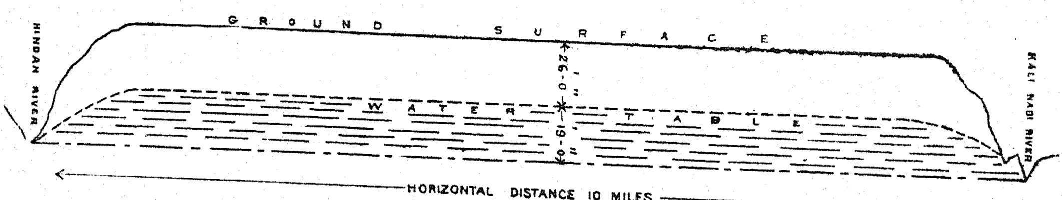

FIG. 1.—Position of Water Table.

In such country the simplest form of well is a hole dug down to a short distance below the percolation-level: this is a percolation well. The water will filter gradually into the hole, mainly from the bottom of the well, and can be drawn out by a bucket as it comes in. That even this crudest form of well is of important economic value may be inferred from the fact that something like a million of them were at work last winter in the United Provinces; their sole merit is their cheapness, since they do not in ordinary cases cost more than from 3 to 5 rupees, but cheapness is an important matter in a country where the possibilities of agriculture are limited by the scarcity of available capital. The defects of such wells are numerous, but the most important is the scantiness of their yield: it is rarely possible to work them by bullock-power, and as a rule the lift used is an earthen pot hung on a counterpoised lever and raised as it fills by manual labour. Those who use such wells have learned by experience that more haste means less speed, and the worker who appears to the onlooker to be wasting his time is in reality waiting for the moment when it will be safe to raise the lift.

The reason of this scanty supply is to be found in the fact that for any particular kind of sand or earth there is what has been well termed a *critical discharge*, that is to say, that from a unit of surface only a certain quantity of water can be safely drawn in unit time; if more than this quantity is taken from the well, the water enters it at an increased velocity, enough to set the sand moving; and once the sand at the bottom of the well is started moving, it will continue to move till the well is filled with sand nearly to percolation-level. If, therefore, a well is overtaxed by being made to yield a supply of water in excess of its critical discharge, the result is that the well is spoilt; and the men who use these wells have before anything else to make absolutely certain that they are not overtaxing the well, and must work slowly, no matter how pressing the need of water may be. Such wells therefore can yield only a discharge proportionate to the area of sand exposed at their bottom: and the cost and difficulty of construction increase so rapidly with an increase in diameter, that this simplest form of well can never give a large yield, and must remain what it is, essentially a poor man's well.

The suggestion will doubtless be made that the area of intake and therefore the supply, can be increased by increasing the depth of the well, and so obtaining a large surface of the sides below percolation-level. The objection to this course is that when water is drawn from the sides they rapidly fall in and render the well useless: when sand flows into a well from below, as has just been described, it has to be moved against the force of gravity, but the sand at the sides of the well has not to meet this resistance and has therefore a lower critical discharge and hence moves at a lower velocity than the sand at the bottom. Even with the wells carried a very short distance below percolation-level, it is usual to line the sides with brushwood to prevent their gradual disintegration, and after a short depth this precaution becomes insufficient and a more substantial lining is required. This problem, carrying percolation wells to a considerable depth, has not been worked out by the people, and its consideration must for the present be postponed.

But some unknown discoverer at some indefinite period hit on a method of making wells with an area of discharge independent of either the depth or the diameter, and where this method is available, its results are so superior that the question of improving percolation-wells becomes of little practical importance. This discoverer hit on the secret of making what are known in the alluvium as spring wells. The nature of these will become apparent from an examination of figure 2.

The ordinary spring well in the alluvium consists in essentials of a hole carried down below percolation-level to the first impervious layer of clay, which presumably overlies a layer of water-bearing sand. The layer of clay is then pierced by a smaller hole, and if the sand-bed below contains water in sufficient quantity, there is an immediate rush of water into the well until it rises approximately to the percolation-level. The initial rush of water is mixed with sand, but after a time, as water is drawn from the well, this admixture of sand ceases and pure water enters. How this happens is a question that was for long a puzzle; but it is now well ascertained that the effect of the first rush of sand is to leave a cavity immediately beneath the foundation-clay, and that this cavity goes on getting larger until its surface area is so great relatively to the velocity with which water enters the well that water passes from the sand to the cavity at less than the critical discharge of that particular form of sand. In a spring well, then, the actual size of the well has nothing to do with the yield: as the yield is increased, the cavity beneath the foundations is automatically enlarged, and but for one important consideration it might be possible to set to work and pump the whole sand-bed dry from a single well, with a diameter only sufficient to admit the pump.

The consideration in question is the effect of such an operation on the foundation-clay. Its tenacity is weakened by each enlargement of the cavity, and except where it is very thick, a time will come as the cavity enlarges when the tenacity of the clay will be overcome and it will fall in. The effect of this is practically to convert the spring well into a

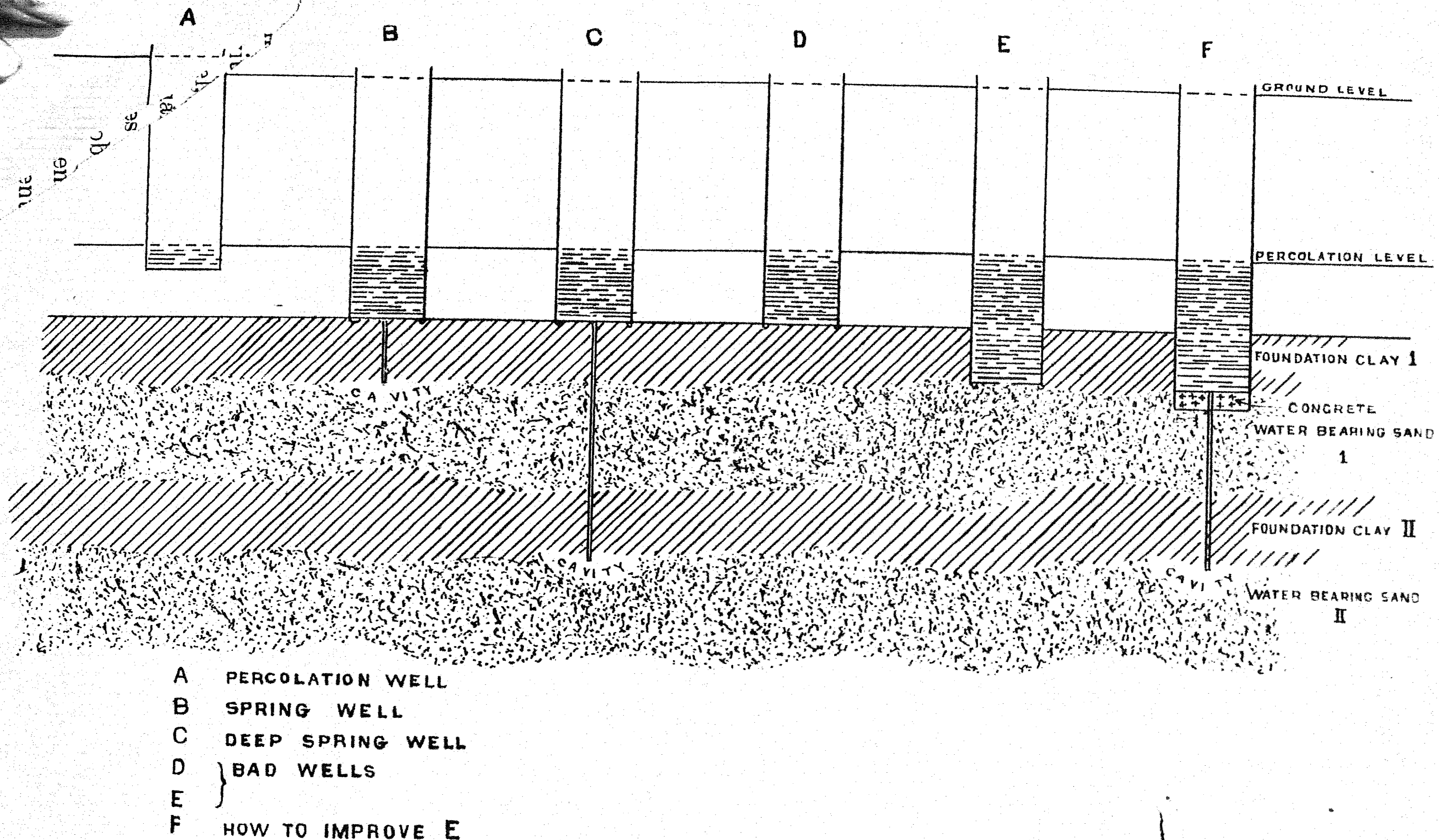

FIG. 2.—Diagram showing various kinds of wells.

percolation-well of a very inefficient type, that is, practically to ruin the well.

Looking now at the diagram (fig. 2), the well A is the typical percolation well, a hole sunk a short distance below percolation-level; while B is the ordinary spring well sunk down to the first layer of clay below that level and then carried on by a narrow hole to the water-bearing sand below. These two types of wells are in practice familiar to all cultivators: they know that a spring well is best, that it requires a layer of impervious clay and that there is danger in overtaxing it beyond a certain limit, just as there is danger in overtaxing a percolation-well. In addition, they have accumulated an extraordinarily extensive mass of knowledge as to the positions where a foundation-clay can be found within a certain distance from the surface, so much so that in considerable areas of the United Provinces it is safe for a cultivator of the locality, but not for an outsider, to start sinking a well without a preliminary determination of the position and strength of the foundation-clay. But, on the other hand, there are also extensive areas where no such knowledge exists; sometimes there is an excellent foundation, but at a greater depth than has been adequately explored, while frequently the foundation is patchy, appearing in some places and thinning off close by, so that thrifty men dare not take the risk of failure and have to put up with inferior percolation-wells.

It must not, however, be supposed that even where a foundation-clay is available the well is an assured success: there is still the risk that the underlying sand may for one reason or another be inadequately supplied with water, a not uncommon phenomenon where the beds are shallow and of small extent. In most countries, it is sufficient before sinking a well to know that there is an adequate supply of water available, but in alluvium of this kind it is necessary to have information not only of the supply but of *the position and thickness of the layer of clay above it.* It is this characteristic which makes the various methods of water-finding practised elsewhere an inadequate preparation for the sinking of alluvial wells.

If now we suppose that the well B has been sunk as shown in the diagram and has failed to give a sufficient supply of water, the only remedy is to carry it down through the first sand-bed and the next layer of foundation-clay in order to tap the second layer of sand. The cultivator is ordinarily unable to do this as the expense of sinking a masonry cylinder to the second clay is prohibitive. But experience has shown that it is quite sufficient to sink an iron pipe about $2\frac{1}{2}$ inches in diameter from the bottom of the existing well down to the second layer of sand, and given proper tools, the cost of this operation is so much less than that of sinking the cylinder that it may be remunerative down to a depth of something like one hundred feet. We then get a well of the type shown as C in the diagram : the cylinder itself is deep enough to give a reservior of water in which the ordinary lifts will work, but the deeper part of the well consists simply of an iron pipe. The sinking of these pipes is not an important branch of the work of the Agricultural Department : tools and trained men being placed out where a demand exists, and it is quite remarkable how quickly a demand arises in a locality where a single well has been successfully dealt with. It is, of course, not always the case that the deeper layer of sand contains sufficient water, but experience has shown that, particularly on the eastern side of the Provinces, there is sufficient prospect of success to justify the operation in all cases where the well as it stands is inefficient.

The wells shown in the diagram as D and E are two ordinary types of inefficient wells. D shows the case where the layer of foundation-clay is too deep to be pierced by the primitive tools within the cultivator's reach. The well as it stands is an inefficient percolation-well, simply because the clay has not been pierced: in this case, the tools sent out by the Agricultural Department can correct the well at trifling expense as they can bore through almost any depth of clay. Such wells are occasionally made by cultivators who happen to light on an unusually deep layer of clay : the type E is, on the other hand, very rarely made by cultivators, but is not infrequently found where the well

has been built by a philanthropist, or by a contractor ignorant of the conditions. In E the cylinder has been carried through the foundation-clay and rests in the sand: it is an inefficient percolation-well, and very liable to subside if much water is drawn from it. The way to correct a well of this type is shown at F: as before a pipe is sunk through the next layer of clay to the deeper sand, and the bottom of the cylinder is then securely plugged with concrete round the pipe, so that no water whatever can enter from the upper sand: this precaution is necessary because if water is allowed to enter, there is still the risk of the sand below the cylinder moving and thus endangering its stability.

It will be gathered from this sketch of the most important forms of wells that there is considerable scope for assisting the public to make existing wells more efficient: but the organisation which has been developed serves equally to assist them by locating suitable sites for wells which it is proposed to make. The same tools which are used for sinking pipes serve for trial-borings to determine the position and thickness of the foundation-clay and the yield of water in the underlying sand: with their aid it becomes possible to make sure of the conditions before entering on what is for the people of the Province a very costly enterprise.

Still, with all possible improvements, wells in the alluvium have their limitations: each well has its maximum safe discharge and the penalty for overtaxing a well is usually its entire destruction. At the same time, it is true that many wells are worked at much less than the safe discharge, and there is a natural anxiety on the part of landholders to increase the yield by substituting power-pumps for the bullock-lift in ordinary use, the efficiency of which is limited both by the power of the cattle and by the diameter of the well. This anxiety gives rise to a very difficult problem, to determine the maximum safe discharge for a foundation-clay of given thickness and consistency: it is obvious that the large pumping-plants adapted for use on rivers and reservoirs would very soon wreck any alluvial well on which they might be installed, while small plants are relatively more expensive to

instal and less efficient to work. If, then, capital is to be invested in pumping machinery, it is obviously necessary for financial success to secure as nearly as possible the maximum safe discharge : and if the maximum is exceeded by even a small amount, the result is the destruction of the well. This problem has not yet been solved, and for the present it is necessary to advise landholders to go very cautiously in the matter, and in particular to be on their guard against those pushing agents who are ready to set up any sort of a pump without reference to the capacity of the well.

In any case, however, the introduction of power-pumps will, for a long time to come, be of interest only to the wealthier landholders as their first cost must place them beyond the reach of smaller men, who will be content to use their available cattle-power to raise as much water as it can manage. Indeed, the clearest result of a somewhat detailed study of the well system of the Province may be stated in the aphorism that protection against drought is mainly a question of supply of capital. Given capital on reasonable terms, the dwellers in the alluvium may be trusted to protect themselves with occasional assistance in overcoming engineering difficulties: and questions of construction and working fade almost into insignificance when we consider the enormous number of wells that are waiting to be made and that will be made as soon as capital is forthcoming.

Note.—The literature on the subject of alluvial wells is remarkably scanty considering their importance to the country. Practically all that is known about them will be found in two books :—

(1) *Papers relating to the Construction of Wells for Irrigation* issued in 1883 by the Department of Agriculture & Commerce of the N.-W. Provinces & Oudh.

(2) *The Manual of Irrigation Wells* drawn up by Mr. E. A. Molony, I.C.S., and issued in 1907 by the Department of Land Records and Agriculture of the United Provinces.

THE AGRICULTURAL CLASSES IN MADRAS, AND HOW TO APPROACH THEM.

By M. E. COUCHMAN, I.C.S.,

Director of Agriculture, Madras.

The presentation of the report of Sub-Committee D. at the last Agricultural Conference at Pusa marks an epoch in the history of the Department. Most of the members of the Department have had a scientific education, and it might be expected that they would be more interested in the biological, chemical and physical problems which their work suggests, than in the practical question of how to influence the ryot. The report of this committee shows a full appreciation of the practical side of the Department's work. The following para. seems especially noteworthy :—

"It must be remembered, too, that one great essential is to find by careful local investigation the *actual* needs of the cultivators, rather than recommend outside methods which may be improvements, but are not acceptable under local conditions."

'Only the wearer knows where the shoe pinches.' Where an actual need exists, the soil is already prepared for the seed. The first requisite, therefore, is to consider in what tracts and among what classes we are most likely to meet with the desired state of things. A timely recognition of the fact that it is only under certain conditions and among certain classes that the Department can, at present, effect any improvements would have prevented much waste of money in the past. It is accordingly proposed to state as briefly as possible the lines on which the prospects of useful work appear most favourable in this Presidency at the present time. Generally speaking, the determining

factor will be the economic position of the cultivator, and not the intrinsic possibilities of the land.

As pointed out long ago by Virgil, want is the basis of improvement. Providence, disapproving of farming being made too easy, sharpens the wit of the farmer by suffering. As long as there is ample virgin land, it does not pay to cultivate the same plot continuously. It would, therefore, be a waste of time to approach the jungle tribes of the west coast and the Agency tracts, who fell and burn a fresh patch of forest each year, and grow a crop in the soil enriched with the ashes, with suggestions for improvement. Generally speaking, each addition to the gross yield of land per acre is obtained at a diminishing net profit on the capital and labour employed. We must, therefore, consider in what localities and among what classes of people engaged in obtaining a living from the land there exists the necessary stimulus to incur this additional outlay for the sake of a greater gross return. The limited resources of the Department in men and money can then be spent to the best effect. Farms will not be opened in tracts where the people are satisfied with their present position, or where such needs as they feel are due to causes beyond our control. Time and money will not be wasted in approaching classes who have no effective stimulus to wish to improve the yield from their land.

Taking the question of localities first, we should expect to find most pressure on the land and therefore the most stimulus to improvement, in the most fertile tracts. To some extent this is so, but, for other reasons, these tracts do not always offer the best scope for the introduction of improvements.

At the bottom end of the scale are vast areas of dry cultivation in regions of uncertain rainfall, such as are found in the Deccan Districts of Madras. Land is very cheap, and population sparse. The simple but effective implements and methods in common use suffice to produce a good crop when the season is favourable, at the irreducible minimum of time and trouble. In the Bellary, Anantapur and Kurnool Districts it is said that thirty acres can be cultivated with a single pair of cattle. If the

rains are favourable, a good crop is secured. The periodical failures of rain protect the land from being absolutely worked out by enforcing occasional fallows. If the rain fails, there is little lost, because little has been put into the land. Such conditions have produced a corresponding cultivator. Possessed of great physical strength and endurance, he is at the same time lazy, because in a bad year industry is wasted, and in a good year the land responds liberally to indifferent tillage.

"Better drink the water which is at hand, than run to a distance to drink milk," is a Telugu proverb which shows his attitude towards possible improvements. True, that in a year when the rains partially fail the man whose land is best tilled will get a better crop, but this would mean extra trouble, if not actually any extra expense. On the whole, the ryot's present methods, taking one year with another, produce enough to satisfy his needs. As long as this is the case, it would be a counsel of perfection to expect him to improve upon them. His methods being thus fixed, any new variety of crops introduced to him would have to be suited to those methods, as much as to the climate and soil.

This is a point which is apt to escape attention, but must be faced by those who seek to introduce superior but more delicate varieties. Till a change for the worse forces him to better his methods, or education raises his intelligence and creates a desire for a higher standard of living, the ryot's methods must be accepted as one of the conditions to which a new variety must be acclimatized as much as to the temperature and rainfall. We seem, therefore, to be on the bed-rock here, at all events in the immediate future. At the other end of the scale are the Deltas, or wet land tracts under equally favourable conditions. The water-supply is certain, and the silt ensures a certain minimum crop every year. Foresight, skill, and industry being at a discount, we find that the cultivator is perhaps the poorest specimen of his class. This is especially true of the oldest Delta system, the Kaveri Delta. Here hundreds of years of practical security against failure of crops have weakened the fibre of the cultivator,

and destroyed his initiative and resource. The high prices which the land sells for show that the present methods, defective as they are, yield a large net return. Till the existing economic conditions can be changed, there exists little prospect of a general improvement. What these economic conditions are, will be seen below. In the meantime the only hope is in the exceptional cases, where the landowner is enlightened enough to break through the prevailing practices of the district.

The most favourable localities at present seem to be those in which the climatic and agricultural conditions are such as to yield a fair return to hard work and enterprise, but not a net surplus large enough to support a large class of non-resident landowners. The best crops are those under well-irrigation. Incessant toil and a high degree of skill are necessary to obtain a living at all, but, given these, crops are a certainty. Such are the "garden" lands of the East Coast, where field crops are grown by lift irrigation from private wells, and the best cocoanut and areca gardens of the West Coast. To these must be added the districts of dry cultivation with a rainfall reliable enough to encourage the cultivators to treat their land well. It may safely be said that any practical suggestion by which their labour could be lightened, or made more productive, would receive careful consideration from the cultivators of such tracts. In such districts, criticism of farm methods is always keen and intelligent, showing that they are on the look-out for improvements.

The next division of the subject is the most important. Among the numerous grades of people interested in the land, from the naked cooly behind the plough, scarcely more intelligent than the animals he follows, to the zamindar, money-lender, or vakil living in the city, which are most likely to listen to the advice of the Department? This is a practical question, because the machinery for effecting improvements must be adapted to the subject-matter. Bulletins and instructors must be suited to influence the class to be approached.

For a long time to come the hired cooly is evidently beyond our scope. He has little voice in the matter or interest in the

result of his work. Next above him comes the "sharer," who cultivates a piece of land, or provides the labour for a crop, on condition of receiving a share of the crop. If his share is a fixed quantity of grain, he has no interest in improving the yield beyond what will be enough to secure this. If he gets a percentage, he has an interest in the result, but could not change his methods without his employer's consent.

The next class is the tenant-at-will, usually on a yearly lease. His status varies from that of a rack-rented bird-of-passage, who pays from half to three-quarters of the gross produce to the land-owner, to that of the wealthy tenant of a poor landlord in a district where good tenants are scarce. Where the tenant pays his rent in the form of a share of the crop, he is naturally averse to increasing the rent paid to his landlord, even though by this means he might increase his own profit as well. An intelligent ryot in the Kaveri Delta is reported to plant his own paddy-land, about twenty acres in extent, with single seedlings, using selected seed, and manuring his land, thereby getting about double the usual crop. He also rents some land on the share system prevailing in the Kaveri Delta, whereby from half to three-quarters of the gross produce goes to the landlord. This he cultivates in the usual slovenly local fashion, preferring to get a smaller return himself with the minimum of trouble, to increasing the share of the sleeping partner in a greater ratio than his own. Even where the share system does not prevail, the tenant-at-will has reason to fear, unless protected by special legislation, that any increase in the produce due to superior cultivation will be followed by an increase in the rent. Where competitive rents are the usual thing, private landowners are not troubled by scruples about taxation of improvements effected by their tenants. It is in this Presidency the common practice for tenants to pay Rs. 100 an acre and more for land for betel or sugar-cane cultivation for which only Rs. 30 will be charged when rice is grown on the same land. There is, therefore, little use in approaching the average tenant-at-will with suggestions for improvement.

Leaving out for the moment the next grade, and working down from the top, we begin with the zamindar, money-lender, vakil, Government official and the wealthy landowning class generally. In most cases these are absentees, and practise some other profession. Their land represents their inherited wealth and their personal savings. Ask a man of this class what rent per acre he receives, and frequently he cannot tell you. He knows that land paying, for example, fifty rupees worth of rice as rent will cost Rs. 1,000 to buy. The better the land, the safer the water-supply, the lower the rate of interest. This class, as a rule, buys only the gilt-edged species of land, such as the wet land in our great Delta systems, the Godaveri, Kistna, and Kaveri, or under rivers fed by the unfailing monsoon of the West Coast, such as the Tampraprani Valley in Tinnevelly. Their interest in the land is confined to the receipt of rent; their knowledge of it derived from the scrutiny of their title-deeds. Most of this class have neither the time nor the inclination to devote themselves to agricultural improvements. A fair number, here and there, evince an abstract interest in the subject of agriculture, but, with a few bright exceptions, the mutual want of knowledge and confidence existing between them and their tenants prevents this bearing any fruit. An exception must be made in favour of the well-educated and enlightened zamindars of the younger generation. Most of them reside the greater part of the year on their properties. Some have home farms under their own management. When the zamindar succeeds to the title while in his minority, and the Court of Wards takes his property under its management, the home farms are managed by the European Expert employed by the Court. In the meantime the minor is receiving a first class education, in which stress is laid on agricultural subjects. There is good reason to hope that in many cases they will carry on their home farms on succeeding to their properties. Should these hopes be realized, more can be expected from this class than from any other.

With this exception, little help can be looked for from the larger landowners in this Presidency.

The class next below this, and next above the tenant-at-will class, is recruited from all grades of society. At one end of the scale we have the small ryot, cultivating ten or twenty acres of dry land in the Deccan plateau with one bullock of his own, and another begged or borrowed from his neighbour. Yesterday a cooly, he has obtained on *Darkhast* a piece of land on the margin of cultivation, investing his savings, of perhaps less than twenty rupees, in the purchase of an old bullock, and few cheap implements. If his first season is a good one, he may permanently rise to the status of a ryot. If not, he becomes a cooly again. The land he abandons goes to swell the total of lands bought in by Government, and provide figures which come in useful to critics of the Ryotwari system.

At the other end of the scale is the large landowner, farming part of his own land because it is his hereditary profession, and supervising the tenants who farm the rest of his property. This class also includes permanent tenants on a fixed rent, mortgagees with possession, renters for a term of years on a fixed rent; in other words, all those who have a direct interest in increasing the produce of their lands. Some of these are being continually elevated into non-resident landlords by the rise in prices, which increases their surplus profits to the point where their land will give them the income they consider sufficient without any personal supervision. On the other hand, this class is constantly being recruited from below by the best of the labouring classes. In Madras, coolies returning from abroad, with money in their pockets, and wider ideas and higher ambitions in their heads, form a small but valuable portion of this contingent. Some guide to the localities where this class can be found in the greatest numbers is afforded by the census figures. The class "cultivating landholders" forms the highest percentage (of the class Landholders and tenants), *viz.*, 90·7 in South Arcot, the home of the ground-nut, essentially the small man's crop, in Coimbatore 87·4, Salem 85·4, Trichinopoly 86·7, Madura 87·4, Tinnevelly 84·7. These are all districts where there is a large amount of well-irrigation and good dry land. In the Tanjore

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Delta the figure falls to 56·8, Malabar to 11·2, Godavari 54·4. The three last districts are perhaps the richest in the Presidency, and their wealth lies mainly in their wet lands.

The proportion of cultivating owners is also high in the Bellary, Anantapur and Kurnool Districts, but, for the reasons given above, the conditions here are unfavourable for effecting improvements. The consideration of the best class to work on leads, therefore, to the same conclusion as was arrived at from the consideration of localities. The most promising field of labour lies in those districts where personal skill and attention are necessary to obtain a good living from the land. In these districts are also found the largest number of the class whom there is the best chance of influencing, because they have a personal interest in improvements. In the immediate future, till our Agricultural Colleges have commenced to pour forth sufficient numbers of well-trained subordinates of the right sort, through whom alone the masses can be approached, it is to the educated section of this class that the Agricultural Department must mainly address itself. Unlike the uneducated ryot, they are used to basing their conduct partly on reason, instead of on custom alone. They are accustomed to looking for information to books and papers, and to acting upon it. They can, therefore, be influenced by bulletins and pamphlets in English and vernacular. The ordinary ryot who can just read a vernacular paper would scarcely ever act on any information contained in it. Reading to him is a mere way of killing superfluous time, not a way of obtaining information on which to base his conduct. The educated classes have travelled, and seen other crops and other methods. Pilgrimages to distant shrines are responsible for many new introductions. The writer was once astonished to see in an unusually dry year, a rude attempt at a picotah in a remote part of Coorg, in which, owing to the heavy rainfall, any artificial method of lifting water is absolutely unknown. On questioning the owner, it was found that he had seen the picotah from the railway carriage during a pilgrimage to Benares. Numerous instances could be adduced to prove the same point

that new crops and improvements are, at present, usually introduced by the more intelligent and educated cultivators. Yet, if the average ryot is to be taught rational methods of breeding and feeding his cattle, of collecting and preserving his manure, of selecting his seed, and cultivating his land, an agency must be devised for influencing the illiterate classes. To trust to new ideas filtering down from the infinitesimal fraction of the population which is at the same time educated and takes an interest in agriculture, is to postpone progress indefinitely. The percentage of 'literate' males among the leading Tamil and Telugu cultivating classes at the last census was as follows :—

Vellalas	...	6·9
Kammas	...	4·8
Kapus or Reddies	...	3·8

Among the literates of these classes the percentage of those who know English was as follows :—

Vellalas	...	3
Kammas	...	1
Kapus	...	1

The reality is even worse than the figures suggest, for, if a member of a cultivating class has learnt English, he has usually ceased to be a cultivator. A glance is enough to prove that no bulletins in English can reach the fringe of the cultivating classes. Vernacular bulletins can be read by only a minute fraction. For the present, therefore, little would be gained by emulating the excellent farmers' bulletins and agricultural journals, the production of which must occupy a large amount of the time of the officers of the Agricultural Departments of other countries. In such countries the Agricultural Experts are usually men of the same race as their audience. Their audience is also educated, and accustomed to look to the papers and to books for information in connection with farming. Even under these favourable conditions, the tones of expostulation and entreaty which are at times discernible in these publications, seem to indicate that much of the seed falls upon stony ground. The Experts of the Indian Agricultural Department are separated by a wide gulf in language, race, customs and ways

of thought from the farmers of the country. They can never hope, therefore, to exercise any considerable direct influence on the cultivating classes.

The agricultural classes here can only be reached by oral instruction given in their own languages in their own villages. The training of the right kind of farm Managers and itinerant instructors, well, but not too highly, educated and preferably belonging to the agricultural classes themselves, must, therefore, be the most important duty of our Executive Agricultural Experts for some time to come. With this end in view, the Agricultural College at Coimbatore has been made as accessible as possible to the ryot classes. The only educational qualification which is indispensable is a knowledge of English sufficient to enable the students to follow the lectures. No scholarships are given, as it was found in the past that these attracted the wrong class of men. On the other hand, free lodgings are provided and no fees are charged for tuition. By this means it is hoped to obtain a suitable agency for "bringing experimental work to the notice of cultivators."

NEW IMPLEMENTS ON THE MIRPURKHAS FARM.

By G. S. HENDERSON, N.D.A., N.D.D.,

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THE following series of photos illustrate some recent introductions of implements designed for the special conditions of the Sindhi cultivator. Some of these are modifications of the indigenous implements of other countries. It is considered that the Sindhi is more likely to take kindly to a simple but efficient and inexpensive tool than to more elaborate contrivances manufactured abroad.

A small workshop has been recently started at the above farm where all the following implements, with the exception of the water-lift, are made. Over 100 applications for ploughs have already been received, and it is expected that after demonstrations have been arranged in the various talukas, and leaflets distributed, the demand will be considerable.

Plough.—On irrigated lands where the ground is softened by water it is an efficient implement. The share is of iron $6\frac{1}{2}''$ broad and the body $3'$ long. It deals effectively with the numerous troublesome weeds generally found in irrigated land. The working depth is adjustable. It will do at the least one half more work than the ordinary Sindhi plough and go $2''$ deeper with ordinary bullock power. A heart-shaped piece of wood fitted into the angle between the draft pole and the body, converts it into a very useful ridging plough. The cost at Mirpurkhas is about Rs. 7. (Plate I.)

Scraper.—This is a useful implement on irrigated lands and especially on a perennial canal. To prevent waste of water it is essential that the ground should be level, and this can readily

be effected by this implement. It is a square box-like arrangement with long handles and a convex bottom, the gathering edge being of iron.

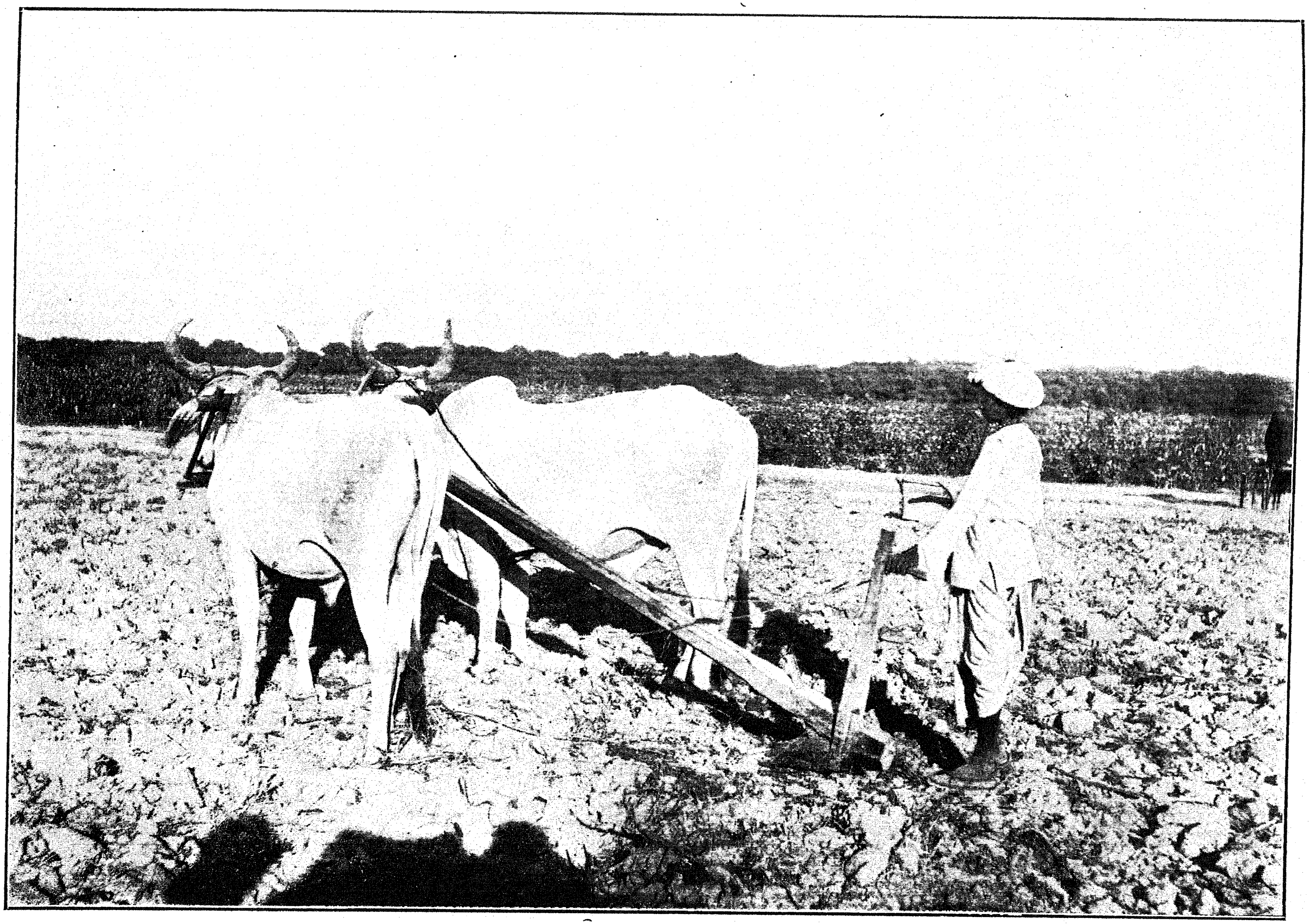
In levelling land generally one plough works along with four scrapers. The scrapers follow one behind the other and gather up the loosened earth. When full, the scraper is simply tilted over at the required spot. The earth can either be spread out evenly or made into embankments. Substantial embankments can be more cheaply and quickly constructed in this way than by doing the work by hand.

When the scraper is emptied, the rope across the handles rests on its draft chain, and it is brought back as in plate III. It is cheap. (Plates II & III.)

Norag or Thresher.—This is a useful machine for threshing any grain and is especially adapted for wheat, as it chaffs up the straw the right length for feeding. Its construction is evident from the plate. The only points which would offer difficulty to a local blacksmith are the cast iron axle bearings. If the discs are kept sharp, it will do four times as much work as the ordinary method of treading out by cattle. The usual manner of working is to pile the wheat or rice, etc., in a large heap; some of this is carefully spread on the ground on the outside of the pile forming a large circle. The "Norag" is driven round this and gradually threshes the whole heap, the circle getting less and less as the loose pile diminishes. In this way much handling of the grain is avoided as the crop is carted straight to the pile. (Plate IV.)

Iron Screw Water Lift.—On a perennial canal an efficient water-lift driven by animal power to raise water generally not more than 3 ft. and often considerably less, is greatly in need. For this purpose on the Jamrao Canal, the Persian Wheel is universally used. On a 3 ft. lift, however, this is very inefficient. A one bullock Persian Wheel on a small lift will discharge probably from ·10 to ·12 cubic feet per second. Plate V illustrates a machine giving an estimated discharge of 1 cubic foot per second on a 2 ft. lift., *i.e.*, will water an acre 1″ deep in an hour. It consists of a double spiral screw working in a masonry cylinder.

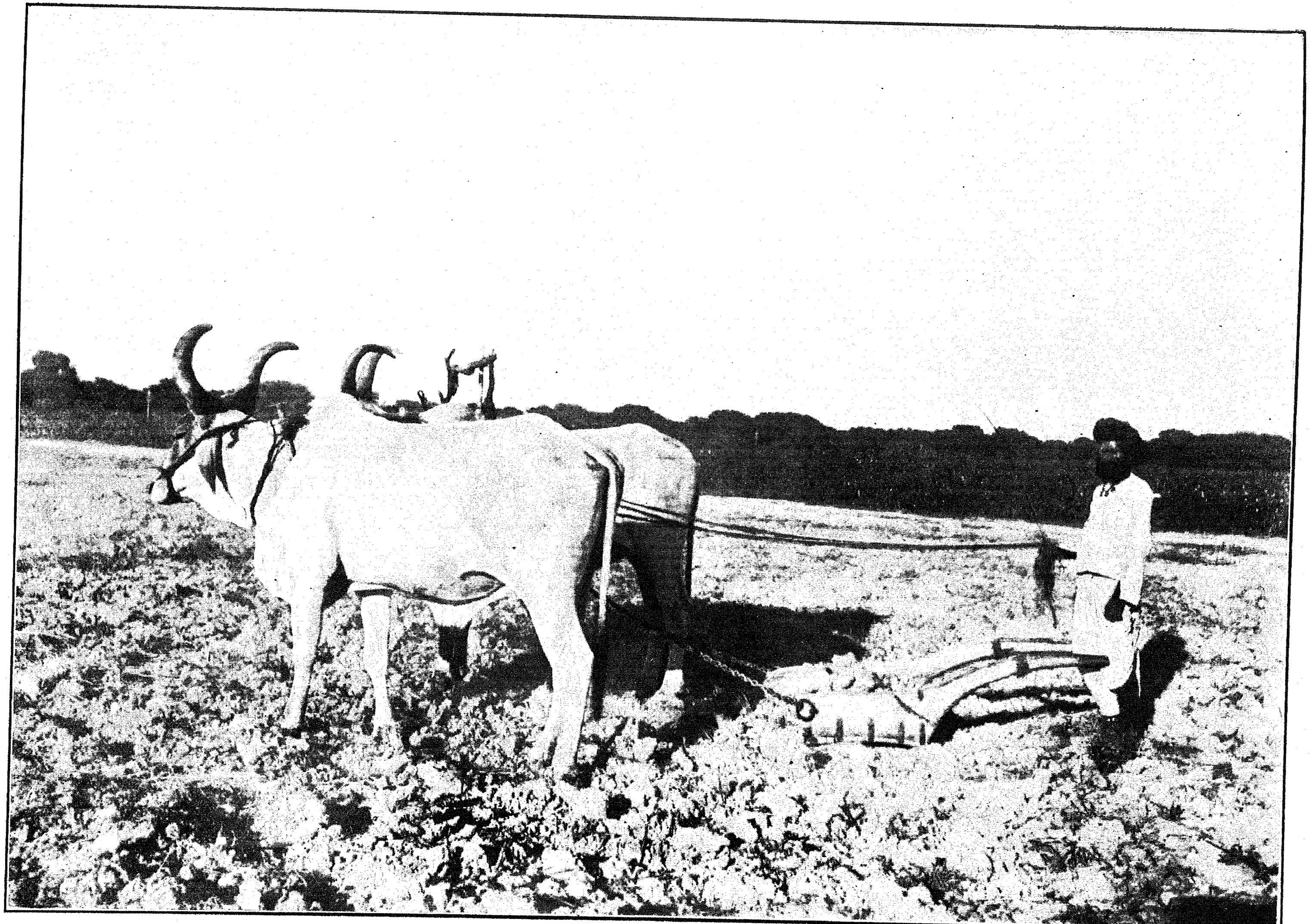
PLATE I.



A. J. I.

PLOUGH.

PLATE II.



A. J. I.

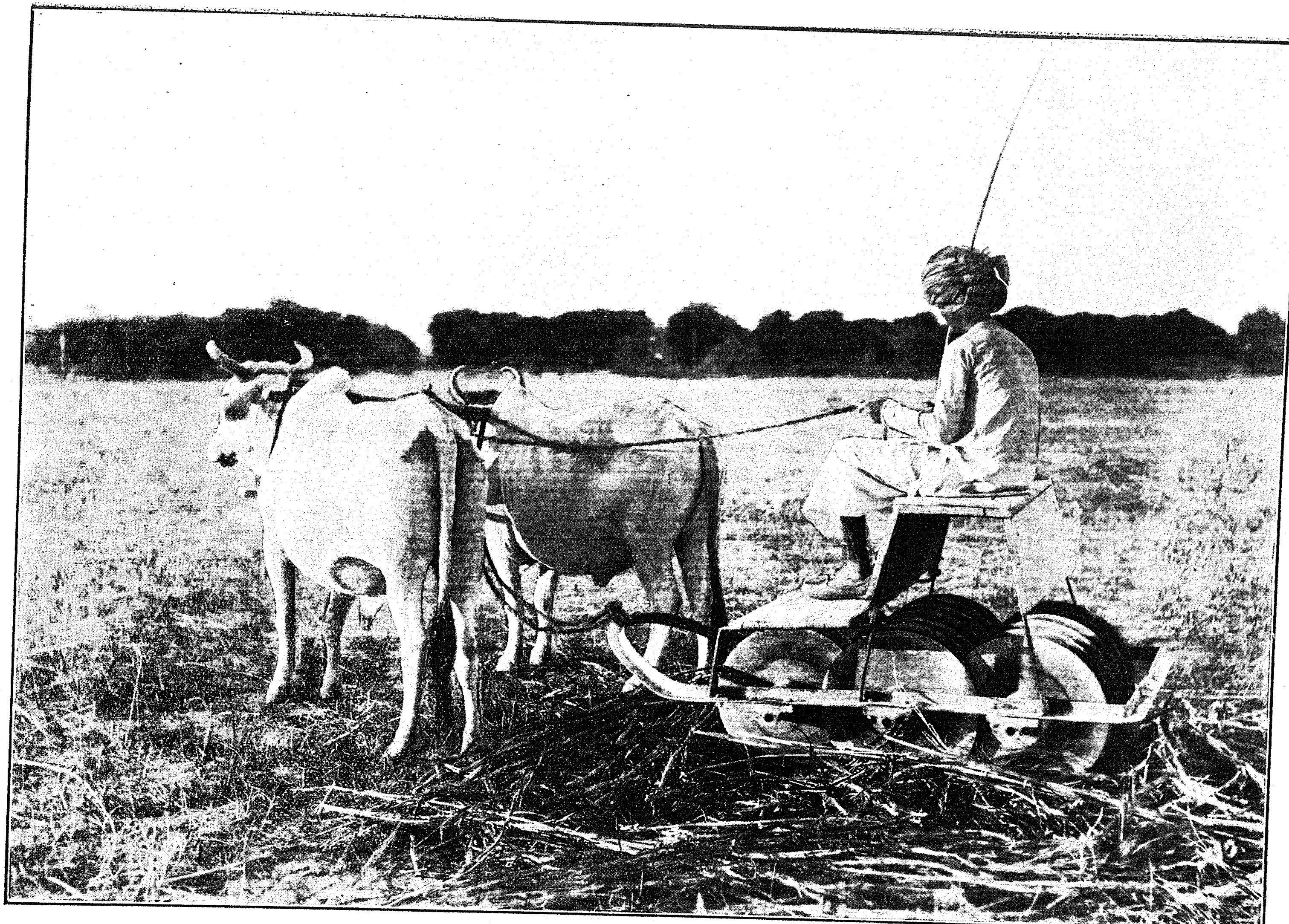
SCRAPER.

PLATE III.

A. J. I.

SCRAPER.

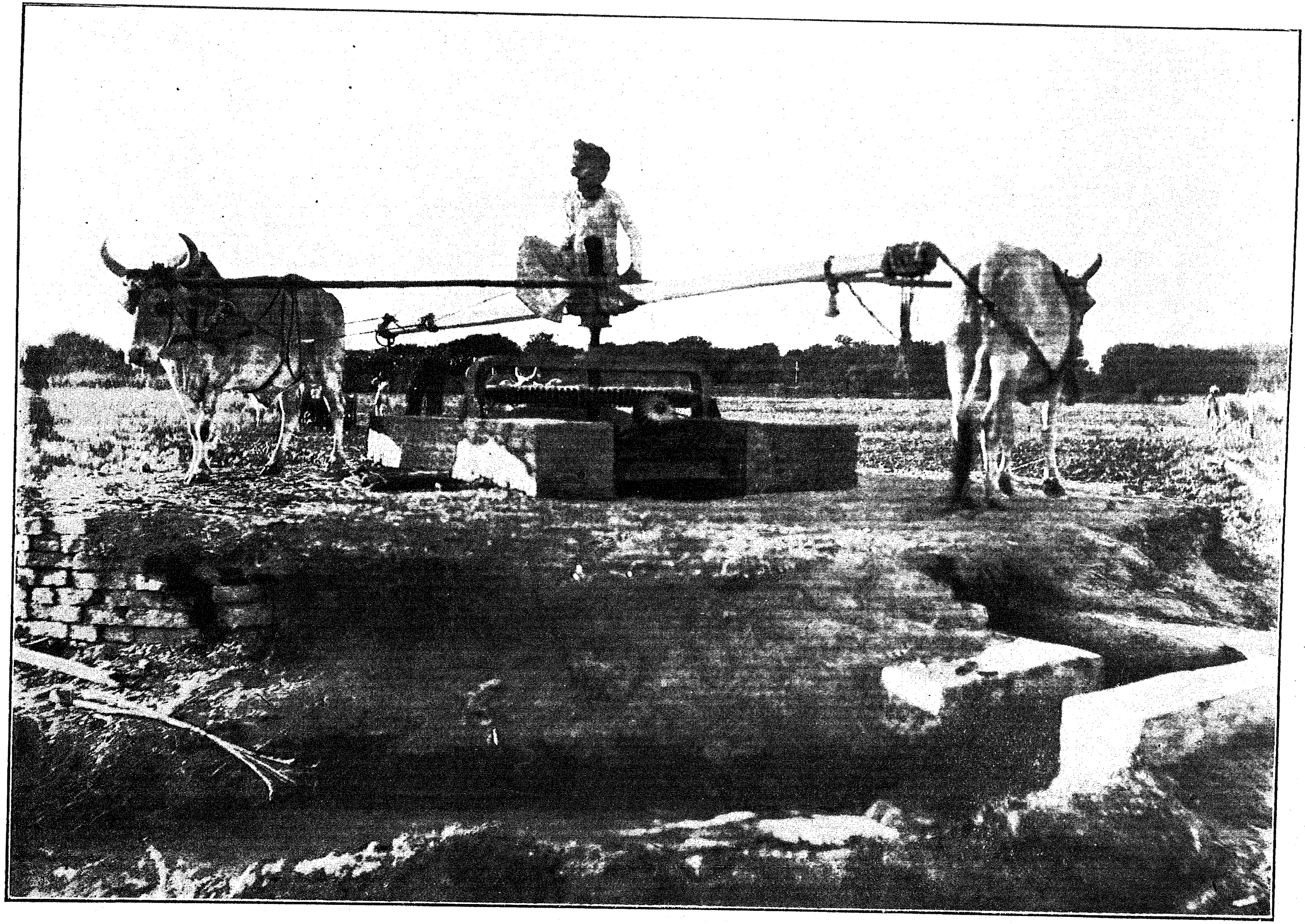
PLATE IV.



A. J. I.

NORAG OR THRESHER.

PLATE V.



A. J. I.

IRON SCREW WATER LIFT.

The cost is Rs. 600/- and unlike the Persian Wheel or "Hurla" does not need to be remade or refitted each season. (Plate V.)

The photos are by Messrs. Gopaldas & Sons, Photographers, Hyderabad, Sind.

THE MANURIAL EARTH OF THE KISTNA DELTA.

By W. H. HARRISON, M.SC.,

Agricultural Chemist to the Government of Madras.

In many of the districts of the Madras Presidency, it is a common practice for the ryots to apply regularly to their lands such earths as are found to be of benefit to the crops. These earths are either the silts which have collected in the tanks and irrigation canals, or certain soils obtained from the vicinity of habitation and villages. The latter practice is general throughout the paddy-growing portion of the Kistna District and the earth used is locally known as Pati-mannu.

Pati-mannu is obtained from the backyards of houses or from places near present village sites which, there is every reason to believe, were once occupied by houses and cattle-sheds. The Telugu ryot lives in densely crowded villages, a custom which has come down from disturbed times, and he is notorious for his devotion to his cattle. The cattle are literally treated as members of the family. The front room of the ryot's house is occupied by the cattle, fowls perch on the rafters, and the human members of the family find room for their beds wherever they can, unless there happens to be an upper story attached to the house. Village sites are seldom changed and consequently the soil in the houses and backyards becomes strongly impregnated with organic matter to a depth of 8 to 10 feet and possesses strong manurial properties.

The only use of this earth until comparatively recent times was in the construction of walls and dwelling-houses, as such structures withstand the effects of rain and heat better than those constructed with the ordinary earth of the district. In

the Ceded Districts, it is largely used for the flat mud roofs of the houses, which are proof against rain.

The use of Pati-mannu as a manure seems to have originated within recent times, as the oldest ryots deny having seen it put to such a use in their younger days and fix the time when this first occurred as about thirty years ago.

Information regarding the place to which the honour of first recognizing the value of the earth, and originating the practice of applying it to paddy-lands, must be allotted, is of the vaguest character. The ryots of Saripalli state that it was first used at Agarru, those at Agarru point out to Palakole and Palakole in turn refers to Jinnur. Although the Jinnur ryots have only very vague recollections, the balance of evidence points, as far as the Kistna District is concerned, to the practice having arisen near this village, but it is more than probable that it was an importation from the southern districts of Madras.

Pati-mannu on inspection *in situ* is found to consist of compressed heaps of organic refuse and earth. Good specimens are ash-grey in colour and crumble to a powder under very slight pressure. It is almost exclusively used on paddy-lands, the only exception noticed being in the village of Uppaluru in the Bezwada Taluq where it is occasionally applied to tobacco crops. The carting of the earth commences after the paddy harvest, at a time when the canals are closed, and during this season heaps of it can be seen lying on the wet-lands near the railway from Bezwada to Masulipatam. This work is vigorously pushed forward and the earth is spread by the end of May, so that the land may be ready for transplanting in June.

In many parts of the Delta some of the low-lying lands are poorly drained, and in these there is a tendency for saline matters to accumulate. Such lands give greatly diminished yields, and even this result is only obtained at the expense of a large amount of labour and water. The ryots use Pati-mannu in conjunction with paddy straw for the improvement of these lands. Soon after the harvest the land is well flooded with water and paddy straw is trampled in, no charge being made by the Revenue

Department for water used for this purpose. The water is allowed to remain for a fortnight before draining off, and then fresh water is admitted and allowed to stand for a further period of a fortnight. After finally draining the land, Pati-mannu is spread at the rate of 100 cartloads per acre and ploughed in. A further dressing of 50 cartloads per acre is given in the following year, followed by 30 cartloads in the third year.

Now that the supply of the earth is restricted, it is difficult to form an exact estimate of the amount applied to the paddy-lands, as this depends upon the wealth of the individual ryot, the accessibility and amount of the earth available, and the nature of the land to which it is applied. Only the wealthy ryots and landowners use it in large quantities, and their practice is to bring on to their lands a regular amount of Pati-mannu every year. This, however, is so distributed that only one section of the land receives a dressing during any one year, and it then receives no more for a further period of six years. The earth is applied in quantities varying from fifty to one hundred cartloads to the acre. Poor ryots who cannot easily command a supply often apply it once in ten years and even then in much less quantity than their richer neighbours. At Kankipad, for instance, a cultivator owning about one and a half acres of land was found to be applying to that area only 20 cartloads of Pati-mannu and this was derived from a wall in his compound. Taking the district as a whole, the general practice appears to be an application of about 75 cartloads to an acre every six years.

The price paid for Pati-mannu varies greatly with local circumstances. In some villages, the price is comparatively low and the supply good ; in others the supply is in the hands of a restricted number who trade on the misfortune of their neighbours. In other villages, the supply is retained for the use of one or two landowners, and the ordinary cultivator cannot get it at any price. At Chattaparru the earth is obtained from the fort at Ellore, two miles away, and the cost to the ryot varies from 14 annas to one and a half rupees per cartload, this price however including cartage. At Dendalur in the same taluk,

there is a large mound of Pati-mannu and one hundred cartloads can be bought for fifteen rupees. Near Gudiwada Station, the mounds cover an area of about 50 acres to a depth of six to eight feet, and these are sold to the ryots by the Inamdar at 4 annas per cubic yard.

Eliminating the excessive price paid at Chattaparru, the average cost is about thirty-two rupees per one hundred cartloads, but in order to arrive at the true cost to the cultivator, it is necessary to make an addition for the cost of cartage. This is a considerable item where long distances have to be covered and adds materially to the value of the Pati-mannu when tipped on the land. The condition of the roads must also be taken into account in forming an estimate, and it is probable that the average cost for this item for the whole district does not vary materially from twenty rupees per one hundred cartloads. The total cost to the ryot is therefore about fifty-two rupees per one hundred cartloads, and this, on the basis of an application of seventy-five cartloads per acre every sixth year, is approximately an annual charge of six and-a-half rupees per acre. In this estimate no account has been taken of the cost of spreading the earth, as this operation is usually carried out by the ryot himself and his family. In cases where hired labour is employed, payment is made at the rate of four annas per day and the cost of spreading an acre can be put down as between one and two rupees. This expenditure, however, is spread over a period of six years and does not materially affect the above estimate. In this connection, it may be pointed out that a cartload weighs approximately half a ton.

It is generally conceded by the ryots that the highest yields are obtained in the second and third years following the application, and that after the fourth year, the crops are decidedly inferior. Lands which only yield from 830 to 1,000 lbs. of paddy when untreated, will give from 1,700 to 2,500 lbs. of paddy after an application of Pati-mannu.

During the course of this enquiry, thirteen samples of Pati-mannu were obtained from different places in the delta and sub-

mitted to analysis. It was found that the percentage of $P_2 O_5$ varied from ·505 to ·909; but if the two extreme values are ignored, the variation is only from ·664 to ·790 per cent. The percentages of potash are, however, very variable, the limiting values obtained being ·52 and 2·02, and between these limits the intervening values were evenly dispersed.

An average sample was prepared from the specimens collected and the following shows its composition: –

Moisture	4·20%
Loss on ignition	4·22%
Insoluble mineral matter	75·51%
Ferric oxide	3·25%
Alumina	6·57%
Lime	2·60%
Magnesia	·78%
Potash	1·39%
Soda	·32%
$P_2 O_5$	·69%
CO_2	·32%
	99·85
Nitrogen...	·094%

Pati-mannu may be looked upon as an earth rich in Potash and Phosphoric acid, and on the basis of this analysis, the amount of plant-food supplied to the land by its agency averages 13 lbs. of Nitrogen, 194 lbs. of Potash and 96 lbs. of $P_2 O_5$ per annum.

The deficiency of this earth in Nitrogen is made good by the almost universal practice of growing sunn-hemp for fodder immediately after the paddy is harvested, and ploughing in of the stubble.

The mechanical analysis shows it to be chiefly composed of finer grade particles, but the amount of clay present in it is only 14%.

The amount of Pati-mannu now available is very limited, and in several parts of the district it is very scarce indeed. Throughout the whole of the Masulipatam Taluk, the sources of supply are practically closed to the ordinary cultivator. Until very recently each ryot had his own supply, which was derived

in most cases from his own backyard and even from the floors of their houses, and in consequence, unsightly pits, some of them ten feet deep, can be seen in and about dwelling-houses, forming such a menace to life and limb, that the Revenue authorities are insisting on the pits being filled in with earth.

In many villages, it is no uncommon sight to see walls, which are constructed of this earth, in process of being demolished and carted away to the fields. Poor ryots are known to sell their houses to be broken up for manure and to rebuild them with the ordinary delta earth.

Cattle manure is exceedingly scarce, as the number of animals kept by the ryots is comparatively small, and the greater part of these are sent away to distant grazing grounds during certain parts of the year. What little is available is chiefly used in the preparation of seed-beds.

Under these circumstances, it has become of imperative importance to afford some relief to the poorer ryots, by introducing some cheap and effective substitute to their notice, and experiments are now being carried out by the Madras Department of Agriculture to further this object.

Cheap mixed fertilizers, the components of which, with the exception of the potash, are easily obtained locally, have been prepared by the Presidency Manure Works, Ranipet, to the specification of the Madras Agricultural Chemist, and enough for about forty acres has been distributed free to selected cultivators near Ellore and Bezwada. Should success be attained, an enormous demand for an artificial fertilizer will accrue, as there are 250,000 acres of wet land in the Kistna Delta alone. It is thought that the fact that these ryots are familiar with the use of a mineral manure will increase the chances of success.

TATA SERICULTURE FARM AT BANGALORE.

By J. MOLLISON, M.R.A.C.,

Inspector-General of Agriculture in India.

The late Mr. J. N. Tata established at Bangalore a small Sericulture Farm about 1898. It was started to help native rearers to control such diseases as affect silk-worms in India, and generally to give technical instruction in growing suitable kinds of mulberries, in rearing silk-worms, in reeling silk and preparing it for market. The little farm has answered these purposes admirably.

Mr. Tata was familiar with Japanese methods. He considered them well suited to India. He got for the supervision of his farm one Japanese Expert of the artisan class and another who knew sufficient English to act as interpreter.

The fittings and reeling machinery for this small factory were mostly imported from Japan. They are simple, durable, inexpensive and efficient. They were put up by the Japanese Artisan Expert helped by an Indian *mistri* and coolies. The Japanese Expert and his wife trained native girls of 10 to 14 years of age to do the reeling. I have repeatedly seen these girls at this work. The work was excellently done.

I compare in the accompanying tabulated statement this work as done by a fieldman of my office after three months' training at Bangalore, and the work done by the most expert reeler in the factory—a young girl.

Reeler.	Nos. of cocoons.	Time occupied in reeling.		Time occupied in re-reeling.		Breakages of fibre at time of re-reeling.	Deniers to test silk.				Waste of silk.	Pure silk obtained.
							Beginning of reel.	Middle of reel.	End of reel.	Average.		
		H.	M.	H.	M.						Ozs.	Ozs.
Girl ...	1,500	6	0	2	34	*Nil*	14 14	13 14	13 14½	13-33 14—16	1—54	3—40
Fieldman ...	1,500	13	30	3	0	26	16 16½	17 18	16 15½	16—33 16—66	1—86	2—89

The motive power for reeling and re-reeling by 12 operators was done easily by a woman slowly working a wooden lever, and this power could have easily done much more work. The 12 girls could, in a day, reel and re-reel about 2 lbs. silk, which was worth at the time of my last visit 17*s.* 6*d.* per pound in England. The value of the refuse silk was a considerable additional item of income, but was not estimated.

The work of mulberry cultivation, rearing silk-worms, improving varieties of silk-worms by cross-breeding, detecting diseases by means of the microscope, preserving cocoons for seed and for hanking, pressing and packing the silk for market, was thoroughly done. Apprentices were taken in free for instruction. A three months' course was required for this purpose.

Bush mulberries only were grown. The rainfall, average temperature and soil at Bangalore and generally throughout the Mysore plateau, appear to be well suited for the cultivation of bush mulberries. Those grown were three grafted Japanese varieties, one Italian variety and four others, probably Indian. The Japanese varieties cannot be propagated from cuttings; the others can. Plants of the Japanese varieties and cuttings of the other varieties can, I understand, be supplied to those interested in sericulture.

The soil of the garden is a good deep dark red loam. Cuttings are first put in a nursery, and when they have rooted, are planted out 5 to 6 feet apart in each direction. In order to maintain a succession of young leaves throughout the year, the various plots are pruned in regular succession and irrigation given when required. Crude sewage and night-soil are used as manure with excellent results.

Young leaves are required for the larvæ when newly hatched. If there is a full supply of these and of more mature leaves when the worms are larger, six or seven broods are reared in 12 months.

Disease prevails extensively in Mysore. The following results were obtained from seed cocoons obtained locally :—

(1) 615 moths laid eggs.

(2) 114 of these moths were diseased as determined by microscopical examination; therefore the eggs were destroyed.

(3) The larvæ from 501 batches of eggs hatched out.

(4) These silk-worms ate 3,566 lbs. of green leaves.

(5) The leaves were obtained from 2·41 acres of bush mulberry in full vigour of growth.

(6) 270 lbs. of cocoons were obtained.

At Bangalore, bush mulberry plantations get worn out even with careful pruning and cultivation in a few years. Young plantations to replace old should, therefore, be formed from time to time. Rotation is desirable. A ten-acre area should probably have 5 acres under plantations established for three or four years or longer, and 5 acres under a nursery, young plantations and other crops. The whole should yield leaves sufficient for 6 or 7 broods in a year, each as large as that referred to above or larger.

Mr. Tata's Expert recommends that the rearing house should be separate and at a distance from the buildings required for storing cocoons and reeling with the object of avoiding the risk of communicating diseases. The rearing building should be constructed so that light and ventilation are fully secured; a thatched roof and a verandah being desirable to keep the day and night temperatures fairly equable.

Expensive construction is unnecessary. A mud floor does very well. There should be a plinth and, exclusive of verandah, a building $20' \times 16'$ is sufficient. The height to eaves should be 10′. The north verandah should be about 10 feet wide and enclosed to form a room. If well lighted, the moths, as soon as they have laid their eggs, should be examined for disease under the microscope in this room, which should have no direct connection with the rearing house. The healthy eggs only should be kept.

In the rearing house, there should be three wooden stands each 5 feet high, three feet wide, each with three shelves, the lowest shelf should be 18 inches from the floor. These stands should be so placed that there is easy access to each. They are required to support the trays in which the silk-worms are fed,

A brood from 600 batches of eggs can be accommodated in one tray when first hatched out, but requires about 150 trays when fully grown.

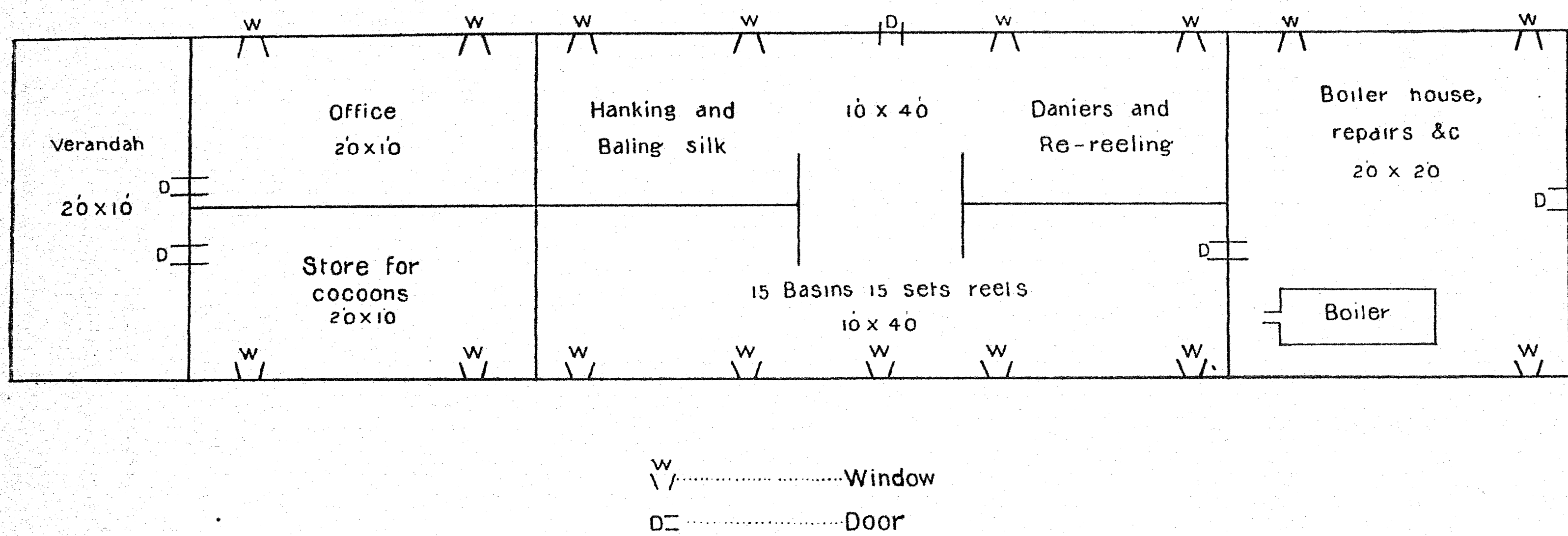
The detailed cost of the fittings of the rearing house is :—

		Rs.	As.
1.	Three racks constructed of wooden frame and split bamboo shelves	30	0
2.	One rack for storing trays, etc. (not in use)	10	0
3.	One table and plank of wood on which the leaves are cut, with a long knife	10	0
4.	Sharpening stone	2	0
5.	A set of four sieves each with different size of mesh for sifting chopped leaves	3	0
6.	160 skeleton bamboo trays, $3\frac{1}{2}' \times 2\frac{1}{2}'$, at 4 annas each	40	0
7.	160 mats, at 4 annas each	40	0
8.	160 nets, $\frac{1}{2}$ inch mesh, at 3 annas each	30	0
9.	Four wooden stands for trays at time of feeding	4	0
10.	24 cocoon spinning screens (*chandrikeis*)	24	0
11.	One Dissecting Microscope, Zeiss	122	0
12.	Table and almirah in verandah room	25	0
	Total Rs.	340	0

The reeling factory should be $90' \times 20'$, and contain (*a*) an office $20' \times 10'$, in which the records should be kept, also in which cocoons for seed and baled silk should be kept ; (*b*) a room $20' \times 10'$ for drying, cleaning and storing cocoons ; (*c*) a verandah $20' \times 10'$, common to (*a*) and (*b*), can be used for drying cocoons in wet weather ; (*d*) a room for reeling, etc., $40' \times 20'$, partially partitioned longitudinally in the middle. On the one side of the partition the basins and reels should be ranged longitudinally ; on the other side, the silk should be tested and re-reeled at one end, and hanked and pressed into bales at the other end ; and (*e*) a boiler house $20' \times 20'$, with an arrangement for steaming cocoons to kill the pupæ. The hand-motive-power should be worked in the boiler house and also the blacksmith and carpentry work done.

The whole building should be constructed on a plinth with brick walls, 10′ feet high to eaves, with tiled roof. The reeling room should have a paved floor and arrangements for drainage. 121 Mud floors are suitable for the other rooms.

FIG. 3.


Verandah
20' x 10'
Office
20' x 10'
Store for
cocoons
20' x 10'
Hanking and
Baling silk
10' x 40'
Daniers and
Re-reeling
15 Basins 15 sets reels
10' x 40'
Boiler house,
repairs &c
20' x 20'
Boiler
W
D
W .... Window
D .... Door

I give a rough ground plan on previous page (Fig. 3). The reeling apartment is of sufficient length for at least 15 basins and 15 sets of reels, and the other accommodation is practically proportionate.

The office will require ordinary furnishings with a vermin proof cupboard for storing seed cocoons. The furnishings are estimated to cost Rs. 50. The store for cocoons should have a large central rack or stand on which in three tiers the cocoons can be stored—

	Rs.	As.
Estimated cost of rack	50	0

The fittings of the reeling apartment at Bangalore cost for 10 reelers as under :—

	Rs.	As.
10 Boiling basins	12	8
10 Reeling basins	20	0
10 Water cups	5	0
1 Reeling table, $20' \times 2\frac{1}{4} \times \frac{1}{2}$	90	0
10 Brass water taps	23	0
10 Steam regulators with couplings	63	0
2 Brass bill corks	5	0
10 Reeling machines on platforms with 80 reels 4 Reeling machines and 16 reels	843	0
Apparatus for baling and testing silk	100	0
Small appliances	20	0
Packing and freight charges from Japan	250	0
Rs.	1,431	8
A Cornish boiler, $7\frac{3}{4} \times 2\frac{1}{2}$, with fire box fittings and chimney and freight charges from Madras	1,265	0
Erection of boiler and setting up machinery in working order with carpenter's and blacksmith's tools, etc., for repairs ...	645	0
Rs.	1,910	0

[illegible] not know the actual cost of the Bangalore buildings. They w[illegible]e simple and inexpensive.

The recurring expenses for cultivation should not exceed Rs. 50 per acre per annum and probably will cost less.

Mr. Tata paid his Japanese Expert Rs. 150 per month at first; now he is also given, I understand, a commission on results.

RESEARCH WORK ON INDIGO.*

BY W. POPPLEWELL BLOXAM, B.SC. (LOND.), F.I.C.

REVIEWED BY J. H. BARNES, B.SC., A.I.C., F.C.S., R.I.P.H.,

Agricultural Chemist, and Principal of the Agricultural College, Punjab.

THE report is divided into four sections, the first of which mentions in brief outline the work done in India by Bloxam, Leake, and Finlow, at Dalsingh Serai, during the years 1902—1904.†

The chief result of this first report was to show the necessity, in the author's opinion, of an accurate and trustworthy method for the analysis of indigo, and he considered that all work on biological lines must remain at a standstill until this point had been satisfactorily cleared up and the analysis of indigo placed on a sound scientific foundation after which it would be possible to investigate the efficiency of the manufacturing methods, and the losses which occur there.

Starting with the estimation of indigotin by means of potassium permanganate, the author had been led to conclude that this method of analysis, even with the improvements suggested by Rawson and Grossmann, was of an empirical nature and of insufficient scientific exactitude, and with the object of improving upon it, a study of the sulphonic acids was undertaken and the composition of their potassium salts determined. The potassium

* Report to the Government of India containing an Account of the Research work on Indigo performed in the University of Leeds, 1905-07, by W. Popplewell Bloxam, B.SC. (Lond.), F.I.C., with the assistance of S. H. Wood, B.SC.; I. Q. Orchardson, B.SC; R. Gaunt, Ph.D., M.SC.; and F. Thomas, B.SC.; and under the general supervision of Mr. A. G. Perkin, F.R.S., F.I.C., of the University of Leeds.

† Account of the Research work on Indigo carried out at Dalsingh Serai from 1903 to March 1904 by W. P. Bloxam, H. M. Leake and R. S Finlow. Bengal Secretariat Book Depôt, 1905.

salts of the four mono-, di-, tri- and tetra-indigo sulphonic acids were prepared and their composition confirmed by analysis.

This being done, Mr. Bloxam and his collaborators then proceeded to study the conditions under which the sulphonation of pure indigotin takes place without loss, an unsuccessful issue to which would render useless Grossmann's method of removing the impurities, as any loss in sulphonation would render the whole process valueless.

Wangerin and Vorländer* state that between the temperature of 95° to 100° C. a loss occurs with an acid of so low a strength as 94 per cent. when heated for half an hour; an acid of 100 per cent. strength gives rise to a loss of 2·4 per cent. in one hour between 95° and 100° C., while an acid containing 8 per cent. of fuming sulphuric acid gives rise to a loss of 8 to 14·2 per cent. according to the time of heating (half to 1 hour).

The results of the author's investigations do not confirm these figures as with pure indigotin no loss was experienced on using 20 per cent. fuming acid for three-quarters of an hour at 97° C.

The tables which follow to prove the author's contentions are noticeable, in that the quantity of permanganate used in the titration is very small, and consequently any error in titration will be considerably magnified in calculating out the results. It would be an advantage if a larger quantity of the sulphonated indigotin solution could be taken for analysis so as to minimise this error as far as possible.

Having made out the case for the pure potassium salt of indigotin tetrasulphonic acid, and shown that no loss occurred in the sulphonation, it remained for the author to prove that sulphonation without loss also takes place when the pure indigotin is mixed with varying quantities of the impurities which naturally occur in indigo cake, such as indigo glutin, indigo brown, and kaempferol; this was done with satisfactory results, and the author states that no difficulty is experienced in working the process on crude indigo varying from 36 to 74 per cent. in indigotin content,

* Zeits f. Farben und Texilchemie, 1902, 1, 281.

and recommends the process as suitable for the analysis of the crude cake of any degree of purity and at any stage of its manufacture.

The authors recommend that in carrying out this process with crude indigo, it is advisable to use fuming sulphuric acid of 5 to 10 per cent. greater strength owing to the diluting action of the impurities; probably what takes place is that the sulphonation proceeds in stages—the impurities being more easily attacked by the acid than the indigotin.

The conditions of sulphonation having been determined, Grossmann's method of purification with calcium carbonate was tested, but here it was found that all the sulphonated impurities were not removed—the analysis with potassium permanganate consequently gave too high a reading—impurities being recorded as indigotin, whilst in other sulphonated products indigotin was precipitated with the impurities and consequently results were too low. The authors, therefore, conclude that the successful application of potassium permanganate to the determination of indigotin depended on the purity of the indigotin solution titrated, and that its application to the analysis of synthetic and crude indigo was not possible in the several processes recommended for the preliminary purification of the crude cake, as these all fail to remove the impurities completely and consequently too high results were obtained in the subsequent analysis; or in the cases when the impurities were completely removed, indigotin was also thrown down and the results of the titration were too low.

Knecht's method for the estimation of indigotin by titration with titanium trichloride was tried, but here the authors found it necessary to introduce some modification in (1) the relative concentration of the solutions of indigotin and titanium trichloride, and (2) the relation of tartaric acid to mineral acid present during the titration.

In order to separate the tetra-sulphonate in a state of purity, the potassium salt was salted out by the addition of potassium acetate with what the authors claim to be quantitative accuracy.

It is worthy of note in this connection that the two chemists to whom the method was subjected for criticism remark (1)* that "the new method of analysis appears to be a distinct advance on the existing methods, as the isolation of a pure indigotin compound from commercial indigo renders the analysis with potassium permanganate much more satisfactory than hitherto. But at the same time care is necessary in carrying out the analysis, for if the author's directions are not followed, the results will probably be *too low*. It is during the process of sulphonation that *great* care must be taken, for if during this process caking occurs, some of the indigo may be destroyed, or if in the salting out of the pure indigotin tetra-sulphonate the operation is not carefully watched, loss may occur; again, if sulphonation is insufficient and some of the tri- or disulphonate is formed, the final results will be too low." (2)† "When working with pure indigotin, the colour of the filtrate (very pale blue) was such as to indicate the presence of more than a negligible amount of sulphonate." Bergtheil also criticises this point and notes that potassium acetate appears to have some chemical action on the sulphonate, so that any inference as to loss of indigotin, based on the colour of the filtrate, may be misleading.

In the course of the first two papers advancing the new tetra-sulphonate method of analysis, Bloxam and his collaborators, in comparing the results obtained with the older and existing methods, offered a considerable amount of criticism on the latter, and it is but fair to note that in many cases the authors of these ascribe the failure to obtain reliable and uniform results to faulty working of the processes.

In view of this lack of uniformity and of the severe criticism of one author's work by another, we shall await with interest the confirmation of these results by some chemist who will be able to give the time to a complete résumé of all the various methods of analysis of either pure or crude indigo; for thus only can we expect

* Prof. J. Norman Collie, F.R.S., Professor of Organic Chemistry, University College, London.

† Mr. A. C. Chapman.

to clear up the existing difficulties in such fundamental questions as the correct indigotin factor for the permanganate solution and the influence of concentration on the results of the analysis.

Now, though the accurate analysis of indigo itself is important, the determination of the quality of latent indigotin (or indican) which the leaf contains is a question of far greater importance in the selection of the best existing varieties, and in studying the efficiency of the manufacturing processes. The authors first tried Rawson's persulphate method, but found it was open to some error, oxidation of the glucoside indican apparently preceding hydrolysis, with the result that as much as 20 per cent. loss was experienced in the analysis. The loss had been already noted by Bergtheil and Briggs * who had proposed an alternative method of applying the reaction.

The source of indigotin or indigo blue in the various members of the indigofera is the glucoside indican which was first isolated and named by Schunck,† and many of the methods proposed for the analysis and valuation of the leaf, and the consequent improvement of the manufacturing processes have aimed at the separation and subsequent hydrolysis of this compound.

Beijerinck‡ in discussing indican suggests the possibility of estimating it by taking advantage of the well-known Baeyer§ synthesis of indirubin by the condensation of indoxyl with isatin. This suggestion involves the estimation of indican by warming its solution with hydrochloric acid and isatin, and determining the amount of indirubin produced, and was further commended by Beijerinck to the authors.

The method was consequently put to an exhaustive test and the following relations established between the three methods :—

Rawson's method	... 56
Persulphate method	... 70
Isatin method giving indirubin of 95 p. c. purity	... 88

* *Journal of the Society of Chemical Industry*, 1906, 734.

† Jahresberichte uber die Fortschritteder Chemie, 188 5, 659 : 858, 465 ; and *Chemical News*, 37, 223.

‡ Proc. K : Akad : Wetensch : Amsterdam, 1899, 120.

§ Berichte, 14, 1745.

This last means an increase of about 50 per cent. over Rawson's method. It is necessary to note here that the persulphate method quoted is the author's modification of Rawson's process and has been criticised by Bergtheil* who shows that this method of applying the reaction will only yield satisfactory results when the plant extract contains a certain proportion of indican; if the concentration of the glucoside alters, the process fails, lower results being obtained.

The point is one of some importance and requires further investigation, as the critical application of these figures to the efficiency of Mahai, as calculated in India, shows that the leaf possibly contains some 20 per cent. more colour material than has hitherto been supposed, and would consequently indicate that the efficiency of the manufacturing methods in use have been over-estimated.

It would be of interest to know what results would be obtained by the application of this modified persulphate method to the analysis of solutions of pure indican at different concentrations.

An examination of the reaction between isatin and indican showed that it was a quantitative one and we† have reason to believe that the isatin method is one which will give us an accurate record of the indican contents of the leaf, always providing that the other organic materials present will not interfere with the reaction. But in connection with this point we note that on page 43 the authors state that the purity of the indirubin thus obtained from the reaction between "plant extract" and isatin was 95 per cent. as determined by Knecht's method of analysis with Titanium trichloride. Now, granting that this method of analysis will give us an accurate indication of the percentage of indirubin in the precipitate, it is evident from these figures that the product obtained some 5 per cent. of impurities. In the discussion which followed the reading of this paper,

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* J. S. C. I., 1907.

† Perkin and Bloxam, *Journal of the Chemical Society*, 1907, 91—1715.

Professor A. G. Perkin stated that he believed the reaction to be quantitative, and it was very unlikely in the process used that any isatin could be reduced to indoxyl, but the reactionability of isatin towards hydrocarbons of the aromatic series, phenols, etc., in which condensation products are formed, seems to have been overlooked, and it would have been instructive if the author had examined the nature of this 5 per cent. impurities, for this impairs the reliability of the process as one of scientific accuracy. We consider that as the method stands at present, it will be necessary to check the indirubin contents of all such precipitates obtained in the analysis of the plant extract, by some such method as Knecht's estimation, and with this addition the isatin process of analysis promises to prove one of great utility in the selection of plants of the Indigofera.

Adjoined is a table* of analysis of dried indigo leaf (taken from the report), and comparing the results of the persulphate method and the determination by the isatin process, we see the apparent value of the latter over the older process.

Variety of leaf.	Indigotin by persulphate method.	Indigotin by isatin method.
	Per cent.	Per cent.
1. Indigofera arrecta, old leaf	0·67	0·87
2. Do. do. young leaf	1·48	1·81
3. Do. sumatrana, young leaf ...	2·43	3·13
4. Do. do. do. selected ...	......	3·53

These figures are of particular interest from the point of view of the indigo producer and have an important bearing on the conclusions drawn by the author as to the efficiency of the manufacturing processes at present in vogue in India.

The specimen (4) which he states to be a dried selected specimen of the *Indigofera sumatrana* yields by the new method of analysis 3·5 per cent. of indigotin (calculated from the indirubin precipitate) or about double the amount of available colour in the specimen of *I. arrecta* examined.

* Page 58.

This on first examination seems a startling discovery and indicates that the planters' stand to again double their output by the use of such a variety of Sumatrana, for the replacement of the old indigo commonly used in Bengal (the *I. sumatrana*) by *I. arrecta* has already in the last eight years doubled the yield of indigo per acre and thus been the means of saving the industry from total extinction.

But if we examine this figure of 3·53 per cent. of colour on the dried leaf, we find that though well above the average, it is not the highest recorded figure for Sumatrana, while the average colour contents of the Arrecta is even higher. Taking 70 per cent. as the average moisture contents of the green plant, and 3·53 as Indirubin of 95 per cent. purity, and the author's figure of 60 per cent. of leaf, we find that the figure 3·53 on the dried leaf indicates a green plant containing ·6 per cent. of indigotin, whereas the average accepted figure for *I. arrecta* is 1 per cent. and often higher.

It is not clear from the report how the author arrives at his opinion that the *average* indigotin contents of *I. sumatrana* is about ·6 per cent.,* and proof is required before this can be accepted as an established fact, and in consequence of this the statement† that the highest efficiency of Mahai does not reach 50 per cent. of the total indigotin available, while the average efficiency is 25 per cent. falling thence to 12·6 seems to be based upon insufficient scientific evidence.

The whole question of the efficiency of the manufacturing methods is of the greatest importance to the industry, for its survival largely depends upon the economic possibilities of improvement in this direction. The introduction of the *I. arrecta* has done much ; it has enabled the planter to double his output of cake indigo, and though it is recognised by all scientific men who have given any thought to the problem that work is needed in the breeding and selection of the indigo plant on an indican content basis, we must also look to improved methods of extraction

* Report, pages 29 and 96.

† Ibid., page 29.

on the most approved scientific lines if natural indigo is to compete on anything like level terms with the synthetic product. Many of the results obtained by the author in the comparative analysis of the leaf, and the assay of commercial indigo cake have a far-reaching effect in dealing with the calculation of the efficiency of Mahai; if, for example, the increased indication of colour contents yielded by the isatin process is, as the authors state, some 20 per cent. in advance of other methods of analysis, and if the leaf contents of the plant average 60 per cent. instead of 40, then, allowing for lower result yielded by Bloxam's permanganate factor for indigotin, the application of these figures to the 85 per cent. efficiency, as calculated by Bergtheil, reduces this figure to an efficiency of 43·7. It is, however, recognised from the analytical examination carried out by Messrs. Rawson and Bergtheil that the process of manufacture commonly in vogue wins only some 50 to 60 per cent. of the colour present. If we apply the above stated correction factors of Bloxam, we obtain as a result a 28 per cent. efficiency for the planter's method of manufacture, and it would thus seem as if improved methods of manufacture could place the planter beyond the effects of competition.

An objection has, however, been raised (see above) against a comparison of the isatin method of analysis with a modified persulphate process which is at present open to criticism. This criticism, together with the noted wide divergence between the leaf estimation as carried out by the author and Messrs. Rawson and Bergtheil, show that it will be necessary to have these results confirmed by further work, and the matter placed beyond doubt before the figures can be taken as representing commercial possibilities or the planters advised to invest capital.

Before leaving the portion of the report which deals with the isatin method of analysis, it will be of interest to look into the application of the reaction and see how the authors deduct an indigotin content from its use.

When indoxyl and isatin interact, there is formed the alpha indogenide of pseudo-isatin, indirubin, and the conditions under

which the beta indogenide-indigotin are formed, appear to be very different.

These two bodies are apparently isomeric and have the same empirical formula, but differ constitutionally; they have different properties, and the conversion of the alpha body into the beta does not appear to be possible,* so that the results of this method of analysis in which the product is weighed as indirubin would be better recorded as weight of indirubin found and corresponding percentage of indican.

The importance of this point is brought out in the subject-matter of the report itself.† When experiments were undertaken with the pure glucoside indican, it was found that solutions of this body could be quantitatively estimated as indirubin by the isatin process, but, on the other hand, the authors did not succeed in obtaining a yield of indigotin, which corresponded with the quantity of colour theoretically present.

Whether this problem can yet be solved still remains to be proved; that it is a point of importance is evident after a close perusal of the subject, but the practical results of the manufacturing inform us that though we can increase the percentage yield of indirubin at the expense of the indigotin (as in the ammonia process), all the known changes rung on the various processes of manufacture have failed to materially increase the yield of indigotin at the expense of the bye-products.

In connection with this conversion of indican into indirubin, Maillard‡ concludes from experiments carried out on chloroformic solutions, that there are most probably two isomers of indigotin—the very soluble and transformable indigotin represented by the formula of Baeyer, and the ordinary stable indigotin which is probably a polymer (di-indigotin), ($C_{32}H_{20}N_4O_4$), and the

* Marchlewski & Radcliffe, J. S. C. I., xvii, 430, claim to have converted indirubin into indigotin, but no quantitative figures are given, and as their results are based only on a dye test, the question at present seems to be an open one.

† Page 94.

‡ Comptes Rendus, 134 (8), 470-72.

cryoscopic determination of the molecular weight by Vauber confirms this view.

A solution of indirubin in chloroform, on the other hand, does not undergo transformation into indigotin, but it is just possible that an unstable or "nascent" indirubin might do so, and that ordinary indirubin is a polymer or di-indirubin.

With the addition of the necessary check to the purity of the indirubin obtained (as indicated above), the results given by the isatin method of analysis then would appear to be most valuable in recording the "indican" contents of the leaf, and as this is the source of the indigo of the manufacturing process, a valuable contribution has been added to our methods of plant analysis, and should prove a specially useful laboratory check in studying the problems connected with the occurrence of indican in the plant and in plant selection.

The next and a most valuable part of the report is that which contains the author's work on indican and the naturally occurring impurities in cake indigo, and we can only say that the work here recorded is a valuable addition to our knowledge of this subject—the paper on indican by Perkin and Bloxam* being specially worthy of mention as a model of clear and concise chemical research.

The results of these investigations indicate that the indoxyl glucoside contained in the leaves of the *I. sumatrana* and *I. arrecta* is in both cases identical with the indican first isolated in a crystalline condition by Hoogewerff and ter Meulen † from the *Indigofera leptostachya* and from the *Polygonum tinctorium*.

By employing acetone as the solvent for the glucoside the authors have shown that it is easy, in the case of the *I. sumatrana*, to rapidly prepare large quantities of the pure substance, in amount equal to about 3 p. c. of the air-dried leaf. With the *I. arrecta* the process, though effective, is not so simple, and the difficulties arise chiefly from the presence of a sugar-like

* J. C S. trans., 1907,91—1715.

† Proc. K. Akad. : Wetensch. : 1900, 2520.

compound ($C_6 H_{12} O_5$), possibly a modification of quercetol which renders crystallisation difficult.

As the isolation of indican can be carried out entirely without the aid of heat, it is evident that the contention of Schunk* in so far as his work with the *Polygonum tinctorium* is concerned, that crystalline indican is an alteration product of his own compound, cannot be upheld.

The authors endorse Hoogewerff's and ter Meulen's statement that indican has the formula $C_{14} H_{17} NO_6$ and crystallises from water with three molecules of water of crystallisation, but its melting point in this condition is 57°—58°C., and not 51°C. as stated in their paper.

Other physical properties and the formation of anhydrous indican are also described. The authors then go on to show that by means of isatin, indican can be quantitatively estimated as indirubin, but, on the other hand, no theoretical yield of indigotin has yet been obtained.

The work of Hazewinkel in which he proves that indican is the indoxyl glucoside of dextrose was confirmed, but the authors note that on hydrolysing the glucoside with hot dilute acids the indoxyl liberated condenses with the formation of brown amorphous products and with the simultaneous production of a trace of indole.

The main product of the reaction which is here termed indoxyl brown has a percentage composition almost identical with the main constituent of indigo-brown, which it very strongly resembles.

	Resulting product of the action of acids on Indican.	Main constituents of Indigo-brown.
Carbon	68·10	68·57
Hydrogen	4·10	4·28
Nitrogen	9·34	10·00

This point is advanced in further support of the opinion expressed in an earlier communication† where the results of the

* *Chemical News*, 1900, 82, 176.

† Perkin and Bloxam, J. C. S., trans., 1907, 91—279.

author's investigations on the constituents of indigo-brown showed that these bodies were probably derived from indoxyl. The percentage of carbon which they contain, together with the fact that they are partially converted into anthranilic acid on boiling with strong alkali, tend to confirm this view.

As derivatives of indoxyl, it is probable that they have been formed by some process of condensation during or after the hydrolysis of the glucoside.

A further study of this question and other points which bear on the behaviour of indican under the conditions which exist in the manufacturing processes on a large scale are being investigated, and it is hoped that further light will be thrown on the relation of indigo-brown to indican, and on the determination of the conditions under which indican yields the maximum percentage of indigotin when acted on by acids or by the enzyme. The results of this branch of the work will be awaited with interest, for they will probably have a profound effect on the manufacture of natural indigo and the industry generally.

The cause of the fermentation process which indigo undergoes in the steeping vat has attracted the attention of many workers. It was first thought that a specific micro-organism brought about the change.* Van Lookeren and Van der Veen suggested the presence of a hydrolysing enzyme, but brought no experimental evidence forward.

Breaudat† obtained evidence of the enzyme when working on the *Isatis alpina* and concluded that in the latter there was also an oxydase which produced indigo from the products of hydrolyses of the glucoside.

Beijerinck‡ found that several commonly occurring aerial micro-organisms were capable of the production of indigo from plant extract, but considered that the hydrolysis in the steeping

* Alvarez (Comptes Rendus, 1887, 115-286).

† Landw. Versuchs. Stat., 43, 401.

‡ Proc. K : Akad : Wetensch : 1900, 120.

vat was brought about by an enzyme, and the view was supported by Hazewinkel* and Van Romburgh.†

They state that the enzyme is insoluble in water and only slightly soluble in glycerine or a 10 p.c. brine solution.

Bergtheil‡ found the enzyme could be extracted with water after the precipitation of the tannin present in the leaf by means of hide powder, and that such a solution, rendered sterile by means of chloroform, retained its activity for some time.

Bloxam found he was unable to confirm this latter author's work, but he succeeded in obtaining the insoluble enzyme of Beijerinck.

In the final summary of the report Mr. Bloxam makes several suggestions for the continuation of the work both in India and in England. He offers a considerable amount of criticism on the methods of analysis in use in India, and concludes that owing to imperfections in these, the percentage of indigotin in crude cake indigo and in indigo at stages of the manufacture is being considerably overstated. He considers also that the percentage of the leaf present in the plant is really higher than is supposed, and that the colour yielding power of the leaf has been greatly underestimated.

The result is, as has been stated above, that the efficiency of Mahai has, in the author's opinion, been very considerably over-estimated.

How far these criticisms are justified is difficult to say, but it appears necessary to obtain further confirmatory evidence on (1) the factor to be used in the estimation of indigotin by means of potassium permanganate, and the influence of concentration on the results of this analysis; (2) the average percentage of leaf in the plant as used by the indigo maker; and (3) the relationship between the persulphate method of analysis used in establishing the efficiency factor of 85 p. c. and the isatin process on which this criticism is based, before it can be said that the

* Proc. K: Akad: Wetensch: 1900, 2,512.

† Loc. cit., 1899, 2·344.

‡ J. C. S., 1904, 85-870.

question of the efficiency of the present methods of manufacturing indigo has been finally settled, or the possibilities of improvement clearly defined.

In the preface to the report there is a lengthy quotation from an interesting lecture delivered by Professor Meldola to the Society of Arts in 1901, and which was entitled "the Synthesis of Indigo." In this lecture the planter has been severely criticised in no measured terms for what is termed his criminal negligence. How far the unfortunate planter is to blame is difficult to say—the members of this industry are men whose interests and knowledge are chiefly centred in the agricultural side of their work, and it seems most unlikely that they were in a position to realise the danger to be faced from synthetic indigo until this was actually on the market and in competition with their own product.

The reports issued from Pemberandah, Dalsinghserai, Sirseah and from Leeds, voice the efforts which have been made both by the members of the planting community and by the Indian Government to place this industry on a firm scientific foundation.

A quotation is given in the report from the *Manchester Guardian* of the 4th September 1907, showing how in the previous year Germany had exported artificial indigo to the value of 31·6 million marks as against 25·7 million marks in 1905, 21·7 million marks in 1904 and 7·6 million marks in 1898. In 1895 Germany imported natural indigo to a value of 21·5 million marks, and this had sunk to 8·3 million marks in 1898, while in 1906 only 800,000 marks worth were imported.

It can be readily understood, then, that during the last few years the industry has not been in the financial position to invest in any doubtful scheme of improvement or even in one which involved the outlay of much capital—the results of Rawson's investigation in India showed a possibility of improvement in the methods of manufacture to the extent of 30 to 50 p. c. by the use of new machinery and improved methods of working, but only a limited number of indigo makers were in a position to avail themselves of this knowledge.

Time after time the English manufacturer has received warnings from the scientist that unless he was prepared at some personal inconvenience and outlay of capital to introduce scientific order in place of his older empirical methods of working, he would ultimately have to give place to competitors who are availing themselves of the resources of science. The whole English world of industry is full of such instances, and it is now becoming generally recognised that there is no subject of greater importance to statesmen and to the British public than the placing of English industries on a sound scientific basis.

We have in indigo a remarkable instance of a venerable industry ousted from the market and starved to death by the results of years of patient work on the part of the German chemists.

The material from which the synthetic indigo is at present manufactured is a coal-tar by-product, and the fact that the source is such is one of the main reasons for the cheapness of the final product. With the improvement of gas manufacture by new and cheaper methods, and with the enhanced value of what have in the past been regarded as waste products, it is possible to conceive that the most economical method of indigo production may ultimately prove to be from the plant, and there is no reason at present to suppose that this should not ultimately prove to be the case.

It behoves those interested in the industry, then, to make every effort to place it on a firm scientific foundation: foundation built on the possession of perfect knowledge; and to this end we trust that all the workers in this branch of scientific enquiry may receive every help and support in their attempt to reclaim at least one portion of Britain's commercial supremacy.

NOTES.

Indian Dry Farming.—Recently much has been heard of American Dry Farming, and large tracts in the South-Western States of U. S. A. which formerly were considered to be too deficient in rainfall to have any agricultural value are now by the proper conservation of moisture made to yield fair crops. The principle is not, however, new and can be seen in the ordinary agricultural practice in many parts of India.

A very interesting and an absolutely scientifically correct adoption of the principle is exemplified in the 'bosi' and 'sailabi' cultivation of Upper Sind. The conditions here in most of the higher lands are an unlimited supply of flow water for a short time, sometimes only 10 days to 2 weeks in mid-summer during the rise of the river Indus. With this water and the help of a little lift irrigation some kharif crops can easily be grown, but a more difficult problem is the production of 'rabi' crops such as wheat and oil-seeds.

The cultivator, however, taught by ages of experience, probably long before America was even discovered, first gets his land flooded and keeps the water on as long as he can by means of small bunds. As soon as the land dries so as to permit bullocks on it, it is carefully ploughed until a fine "tilth" is produced. Thereafter the ground is gone over with a heavy log and the soil carefully consolidated. This corresponds to the American sub-soil packer. A final light ploughing may then be given. The ground will be left till sowing time in October or November or later, and sown by a small drill consisting of a tube fixed to a plough. This does not turn up the soil and so the minimum of evaporation is secured.

On good retentive soil a fine crop can be raised without any further moisture being received, either irrigation water or rainfall, though on poorer soils the crops may be helped out by several applications of well water.—(G. S. HENDERSON.)

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NOTE ON TAPIOCA.—The usual practice of sun-drying tapioca in this country is to remove the skin first, then cut it into thin slices and expose the slices to the sun for 5 or 6 days consecutively until they are quite dry. This method is quite sufficient for the preservation of the root, and for the removal of all the bitter stuffs, if there are any. Boiling before sun-drying is not practised here and is, I think, not essential.

Removal of the skin of the root before cutting it is, in my opinion, advantageous. It must be remembered that the skin consists of an inner and an outer layer. It is enough if at least the outer layer is removed. If it is not done, drying will be more difficult, and will require a longer time. Also there is the danger of the earth that sticks to the outer surface of the root getting mixed up with the cut slices unless special care is taken to wash all roots thoroughly before cutting them. Thorough washing is rather difficult and tedious, and so it is better simply to remove the skin. The extra expenses to be incurred for this will not be much, and whatever is spent can certainly be realised in the price.

Tapioca is a cheap and nutritious food which will serve the people well, especially in times of famine. It has been in Travancore for the last 30 or 40 years, I think. It is very widely cultivated at present and is the staple food of many thousands of poor people.—(N. KUNJAN PILLAI.)

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TOBACCO GROWING IN HALLA TALUKA, SIND.—The cultivation of tobacco at several places in the Halla Taluka of Hyderabad District (Sind) presents several points of interest. The best land is found in patches and is practically all in the hands of "Bania" cultivators who rent it from the Mahomedan owners and zemindars at an annual rent of from Rs. 8 to Rs. 10 per acre. This

land occurs in the courses of old Indus branches or canals and is generally fine alluvium.

Persian tobacco is the variety chiefly grown.

The following notes are from the report of a farm probationer sent to investigate the typical tobacco areas.

Preparation of soil and rotation.—The cultivators believe that if tobacco is rotated with other crops, yield and quality are unfavourably affected. Consequently on the typical areas, tobacco is grown year after year. The preparatory tillage is thorough and is a great contrast to ordinary Sind cultivation. After a good tilth is obtained, the land is thrown into ridges from 26 inches to 30 inches apart, and the ridges are then flattened down on the top. The preparatory cultivation begins when irrigation water is plentiful with the Indus flood.

Manuring.—Large applications are given and 200 donkey loads per acre is common. Goat manure is in all cases preferred, and this is carefully saved and generally commands a high price.

Seed-beds.—For this purpose sheltered land is selected to protect the seedlings from the hot winds in May and June. The soil is well prepared and ridged with narrow ridges. The seed is sown in these seed-beds, when water is available generally in the end of May or beginning of June. It is mixed with sand or ashes and sown on both sides of the narrow ridges. The beds are well irrigated in the furrows. The seedlings are transplanted when 5 inches to 6 inches high or from 40 to 50 days after sowing.

Transplantation.—In the beginning of July, the fields are ready for transplantation, and the seedlings are removed in baskets with moist earth round them. They are planted on both sides of the ridges alternately, not opposite each other, about 1 foot apart; while young, they are watered frequently, but care is taken that the water runs along the furrow but does not touch the plants. The irrigation is continued for about three months.

Hoeing and topping.—Until the leaves of the plants spread out considerably, weeds are kept down by frequent hoeing with the "kodars." The plants are topped just before flowering,

about three inches of the leading shoot being cut off. This is usually done about six weeks after transplantation. The leaves are thus strengthened, and the plants are prevented from running to stem. They are generally allowed to reach a height of between 3 feet and 4 feet. Among careful cultivators subsidiary shoots from the lower portion of the stem are picked off every week. This helps the development of the main leaves.

Harvest.—The crop is cut in October, generally in the early morning while the dew is on the plants, by stripping off the leaves as they mature. These leaves are spread on a threshing floor in the sun for a couple of weeks. They are then collected and put in small heaps for a few days till quite dry and then covered with mats and straw and pressed down by stones or otherwise. They are fermented in this way for two weeks when they are ready for market.

The stems after the leaves are cut send out flower stalks, and these produce seed which is gathered for the next year's crop.

Outturn.—A good crop on the lands above referred to is about 20 maunds (of 81 lbs.) per acre of cured leaf while 25 maunds is considered a "bumper" crop. The wholesale price is usually about Rs. 10-12-0 per maund.—(G. S. Henderson.)

* * *

The Cultivation of Turmeric on the Foot-hills of Toungoo, Burma.—The watershed separating the Sittang from the Salween in Burma is succeeded beyond its western declivities by a series of forest-clad hills and dales commonly known as the "foot-hills" of the range. This tract is intersected by winding streams whose waters are clear in the dry months of the year. In the rains, the waters of these streams carry a good deal of silt which fertilises the cultivated lands of the valleys of this region.

The light-free sandy loams overlying the reddish and yellowish sub-soils of the Toungoo District in Burma are preferred by the Shans for the cultivation of turmeric and most other crops. The humid atmosphere of these parts favours the growth of the ordinary crops.

Turmeric and other crops of the same order grow luxuriantly in shady spots.

Wild turmeric and ginger are indigenous in ever-green forests of Burma. The economic uses of these plants are few and local. The leaf shoots, stems and root stocks of the pungent and fragrant varieties enter into the varied diet of the Shans. Some varieties are only used medicinally.

The cultivated kinds of these two crops are grown by the Shans with care separately. A mixture of other crops is usually grown.

The following is a brief description of the method of growing turmeric by the Shans :—Rhizomes of the plant are selected at harvest in December—January for planting in the following season. They are stored under soil and are kept there until the planting season, April—May. The plant is practically dormant in the season intervening between harvest and planting-time, therefore the buried rhizomes, though sometimes watered, do not send up shoots or suckers. They lie dormant through the rainless months ; at planting time they are unearthed and broken up into sets of suitable size.

The crop is sometimes grown on newly cleared land, in which the trees are felled and burnt. The larger logs and stumps that survive the flames are allowed to lie upon the land. When the South-West monsoon rains set in, holes from three to six inches in breadth and depth, are dug uniformly with a narrow hoe, a foot or fifteen inches apart. Into each of these pits, one or more sets are planted, covered with earth and pressed down by the foot of the planter. The crop is weeded once or twice, but no other cultivation is given. At harvest, the rhizomes are dug up and stored for seed or prepared for market. Those intended for sale are carried in baskets to the nearest stream and thoroughly washed. They are then boiled in spring water, until they yield to pressure between finger and thumb. After this they are thinly spread out upon mats to dry thoroughly in the sun. They are then sorted into different classes and stored in bamboo baskets for use or sale.

On the foot-hills of Toungoo, three kinds of turmeric frequently occur side by side over one and the same clearing or field. They are :—

(1) San-win-gale, the 'lesser turmeric,'
(2) San-win-gyi, 'the greater turmeric' and
(3) San-win-pyi, the 'white turmeric.'

All three kinds have broad light green leaves that stand from three to five feet above the ground. The rhizomes of the first command the best price; those of the second are comparatively coarse; while those of the third, unlike the root-stocks of the first and second, contain no yellow colouring matter and have, therefore, been named 'white turmeric' by the Shans. The plant is not regarded as turmeric in the sense in which (1) and (2) are, though it too is a species of *curcuma*. Its rhizomes, when cut, show a buff-coloured surface and, when crushed, emit a remarkable odour somewhat resembling that of mangoes. The plants of this kind are pulled by the planter as they are believed to injuriously affect the rhizomes of the better kinds. This variety may, however, have special merits which at present are not understood, but which require investigation.—(A. M. SAWYER.)

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PREPARATION OF VINEGAR FROM SUGARCANE JUICE CARRIED ON AT NAVASARI, BILLIMORA AND BULSAR.—The Mobeds (Parsi Priests) of Navasari (Surat District, Bombay) purchase cane juice from the cultivators of the adjoining villages of At, Ethan Mandir, Kachhiawadi and Jalalpur for the purpose of making vinegar. The crushing season begins generally in the middle of December and lasts up to the middle of March. The juice is sold in tubs; the capacity of each is 52 gallons. The juice is not weighed.

The Mobeds of Billimora and Bulsar get the cane crushed in their presence. Special attention is paid to the following points :—

(*a*) To get concentrated juice containing a large percentage of saccharine matter;

(*b*) Cane crops which have been recently irrigated are rejected;

(*c*) the top and the butt portions of canes are removed before the canes are crushed.

The Mobeds of Billimora and Bulsar do not sell fresh vinegar, but allow it to remain for some months to make it strong. This vinegar fetches a higher price than that made at Navasari, because at the latter place the arrangements referred to above in connection with the crushing of canes are neglected.

The juice is brought in large vessels to the *Karkhana*, and filled into jars to three-fourths of their capacity. The mouths of the jars are covered with cloth, and are then kept exposed to the sun, so that fermentation may begin. When froth appears on the surface, the jar is opened, and the juice is strained through a piece of cloth into another jar. This straining accelerates the production of vinegar. Straining is required every eighth or tenth day after the froth appears, but later it is required about every fortnight till the juice turns into vinegar. Vinegar is produced usually in 3 to 3½ months; but the time depends upon the quality of the juice and upon the character of the season. The warmer the weather, the quicker the vinegar is produced. If sufficient time is not given, the change from sugar to alcohol and alcohol to vinegar is not complete. The juice containing a large quantity of sugar turns quickest into vinegar by the above described process.

Fifty-two gallons of juice yield from about 32 to 36 gallons of vinegar. Vinegar is occasionally prepared from the scum obtained from the boiled juice of sugarcane. This scum ferments soon and can be quickly converted into vinegar.

Vinegar is sometimes prepared from dates for household use. The extract in water from the dates is allowed to ferment in vats. When fermentation sets in, the liquid is strained through a piece of cloth into another vat. Straining is done every eighth day or so, and in about three months the product becomes vinegar. Vinegar prepared from dates is said to be excellent in flavour and strength, and commands a high price.

The vinegar manufactured at Billimora and Bulsar obtains a high price. A cwt. is usually sold for Rs. 8 or 9. Vinegar prepared at Navasari is sold usually at Rs. 3 per cwt. These rates are wholesale. The retail rates are about Rs. 18 per cwt. for Billimora and Bulsar vinegar and Rs. 6 to 7 per cwt. for Navasari vinegar.

Process of making vinegar.—In making vinegar from cane juice earthen jars are chiefly preferred. There are other means which are not so cheap or desirable.

Jars.—There are two kinds of jars made of *pucca* earthenware, one having a capacity of about 20 gallons and the other of about 45 gallons.

The price of the former is about a rupee and that of the latter from Re. 1-8 to Rs. 2. Before the sugarcane juice is put in, these jars are plastered inside with lac.

Jars can be used for manufacturing high class vinegar for about five years only. Navasari manufactures vinegar on a large scale and exports the whole quantity in hogsheads to Bombay. A small portion is sent to Ahmedabad, Broach, Surat, etc. The vinegar manufactured at Billimora and Bulsar being of good quality is sent inland as far as the Central Provinces, Central India and Northern India.

Uses.—Vinegar is chiefly used in India by Europeans, Parsis, and Mahomedans for pickles, *chatnis* and such like. It is also used by Hindus as a medicine. In high fever it is prescribed as a cold outward application. It is also given to cattle.

Preparation of Vinegar in the Surat District from Palms.—Vinegar is prepared from the juice of palm trees (*Borassus flabellifer*) in the villages of Bhatha in the Chorashi taluka and in the village of Damka of the Olpad taluka. A man is given 30 to 40 trees growing in one place for tapping during the season and is paid at the rate of Rs. 10 a month or a part of the net profit. The Government duty is Re. 1-8 per tree for manufacturing vinegar. In the year 1907-8, about 200 trees were given in each of the talukas for the manufacture of vinegar. The trees when about fifteen years old are ready for tapping, and they live for 60 years.

There are two seasons when the palms begin to throw out flower stalks: (1) about October and (2) about February.

The sap is extracted from the flower stalks. Both the male and the female trees are tapped for their juice. In a male tree the finger-like clusters are first beaten with a stick along their whole length and then tied together; while in the female, the flower stalks are first strongly tied to check their further expansion, and the embryo is crushed. Thin slices are every day cut off from the ends of these stalks for about ten to fifteen days till the sap begins to flow out. When the juice begins to flow, the finger of the male tree and the spike of the female tree must have their points cut every morning and evening. The juice as it oozes out is collected in earthen chatties placed over the stalks in a slanting direction and covered with sheaths of straw. Every morning the chatties are emptied and replaced, the stump cut until the whole is gradually exhausted and cut away. The average yield of a tree per year is calculated to be 60 gallons of juice. The female trees yield much less.

The tapping operation, though slack in the rainy season, goes on for ten months of the year and gives employment to the professional workers almost all the year round. A tree continues to yield for four or five months. The juice extracted from the palm trees is believed to be purer and cleaner than that from the sugarcane.

Preparation.—Vats are filled to three-fourths of their capacity with juice and their mouths covered with cloth. They are put in the sun for fermentation, which sets in in about six to eight days, and when the froth appears on the surface, the stuff is strained into another vat. Straining is done every sixth or eighth day, and in about a month and a half the product becomes vinegar. The period required for fermentation depends on the temperature prevailing at the time of the year. The vinegar is put in a wooden cask and sold. The wholesale rate of vinegar prepared from toddy is about Rs. 2-8-0, and the retail rate about Rs. 5 per cwt. This vinegar is exported to Bombay, Ahmedabad, Baroda, Ajmere, etc. Vinegar prepared from palms does not

generally keep well for more than two years as it is not strong. It has a dirty white colour, whilst that prepared from sugarcane juice has a reddish colour.

The total quantity of vinegar prepared in the Chorashi taluka was 9,861 gallons in the year 1907-8, and that prepared in the Olpad taluka was 3,196 gallons only as the work of the latter depôt lasted only for five months. One hundred gallons of toddy palm juice give about 75 gallons of vinegar. Vinegar is known in Gujrati and Hindustani as *Surka*.—(D. P. MANKAD.)

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THE SINGHARA NUT.—Singhara *(Trapa bispinosa)* is a herb found floating on the surface of tanks, lakes and pools throughout India and Ceylon and is commonly found in the Madras Presidency. The nut of this plant is used as a food in Kashmir and the north of India, but in Madras it is practically unknown, although some of the poorer classes may occasionally be seen eating the boiled kernel. A sample of the flour prepared from the kernel gave the following analysis :—

Moisture	10·20	per cent
Ash	3·22	„
Crude fibre	1·53	„
Oil and extractives	·60	„
Reducing sugars	Heavy	trace.
Other sugars	2·52	per cent.
Starch	72·44	„
Proteids (N x 6·25)	8·78	„
	99·29	
P_2O_5	·846	
K_2O	·931	
NA_2O	·334	
Nitrogen	1·404	

The flour was found to be devoid of gluten, and therefore could not compare with wheat flour from the point of view of bread-making, but it would answer the purposes of much native cookery.

The proteid content is about equal to buckwheat flour, is higher than barley and Indian-corn flours and is lower than

wheat and rye flours. The crude fibre value is high, but this is due to the sample containing coarse substances derived from the integument of the nut and which would be removed by the simplest "bolting" process.

The starch consists of separate ellipsoidal grains with a central hilum, which rarely forms a cleft. The polarization crosses are very distinct and a brilliant display of colour is produced by a selenite plate. The size varies from 8 to 40 μ, the common size being about 34 μ.

According to the *Dictionary of Economic Products*, the plant is largely cultivated in Kashmir and the north of India, and in the former place forms the staple food of 30,000 people for at least several months of the year.

The kernel is rich in starch, resembles the chestnut in flavour, and can either be eaten raw or cooked.

The cultivation is not attended with any great difficulty. Towards the end of January the seeds are scattered on the surface of the water, where there is no chance of their drying up before the rains, and then pressed into the mud where they soon begin to shoot. In June any excess is thinned out and transplanted. In October the nut forms below water and the fruit is gathered in November and December.

In view of the fact that the nut is nutritious and is common throughout the country, its cultivation may be recommended as forming a standby in bad seasons when crops might altogether fail.—(W. H. Harrison.)

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Fishing Industry in Madras.—Sir F. A. Nicholson, K.C.I.E., I.C.S., whose "Note on Agriculture in Japan" was reviewed at some length in a previous number of this Journal (*A. J. I.*, Vol. III, Part I), has recently published the final results of his preliminary investigations in regard to the establishment of a Marine Fisheries Experimental Station in the Madras Presidency. "We want to develop," says Sir Frederick, "*gradatim et pari passu*, the fisher folk, the fishing industry, and the fishing trade, by methods which will not necessarily reduce their position

to that of hired labourers under capitalists (European or otherwise)."

The present fishing industry in Madras is almost entirely "inshore" fishing and will not therefore be affected by the investigations which will be concerned with "deep sea" fishing beyond the three or four-mile limit. The principal object of the investigations is to provide cheap food to the "75 to 90 per cent. of the population who will always eat animal food if they can get it, but who cannot afford more than 2 annas or so per pound for good solid nutriment, and even less for ordinary fish or flesh." As it is, a very large proportion of the fish that is exposed in markets is "tainted" and unwholesome. The enquiries of the Experiment Station will, therefore, among other things, be directed to the preservation of fish, not by expensive European processes, but by indigenous methods, such as preparation with tamarind, turmeric and red pepper. The question of rapid transit will also receive consideration.

Several useful industries connected with the by-products of fish (oils obtained from the blubber, the skins, shells, etc.) are successfully carried on in America and represent in value an annual outturn of over 10 million dollars. It is natural that the Experiment Station should also concern itself with these, and Sir Frederick Nicholson recommends a set of tools and plant for the manufacture of pearl buttons. His observations in regard to this industry are of interest. "It is not generally known," he writes, "that pearl-shell, a by-product of the pearl fisheries, is exported from Ceylon in enormous quantities every year; in 1906 the export was 13,800 cwt., of which Germany took more than half, Japan about 1,150 cwt., and Great Britain only 922 cwt.; in ten months of 1907 the exports were 10,575 cwt., of which Germany took 7,002. These are for common pearl button-making, and of course only perfect shells are worth sending; allowing for breakage and useless portions, possibly half of the weight of the shell is actually utilised for button-making, so that freight and other charges are paid on a mass of useless material. The shells are sent in bags or wooden cases; if sent in

bags, the packing cost is less than if in cases, but breakage is considerable. But it actually pays to send pearl oyster shell, say, to Germany and the United States of America, to pay cost of packing, freight, breakage, agency charges, etc., and to work them with expensive labour into cheap pearl buttons, which are again sent out here for sale. This is one of the absurdities or scandals of Indian industry; there is little enterprise, knowledge or capital needed to start this business in India (or Ceylon) and to save all the intermediate costs, while promoting a new industry which ought not merely to supply India, but Europe, with buttons. In the case of India, a supply of shell, when our own supplies are exhausted, could be brought over to Tuticorin, etc., by native craft at minimum cost, especially by Kilakariai boats returning from pearl fishing, and it is to be noted that whereas only perfect shell can be sent to Europe, there are millions of less perfect or partly broken shells, which are perfectly available for working up on the spot."—(C. S. RAGHUNATHA RAO.)

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THE INDIAN PENS.—Pens in common use in the vernacular schools of the Bombay Presidency are made from the culms of (1) *Andropogon halepensis*, Brot., which are white, soft and solid. The plant which is very cheap is abundant on the banks of the Deccan rivers in shady places and is also found in large quantities on moist lands in the Konkan and Gujrat.

The culm of another grass which is black and hollow is also sold in the bazaars for making pens. Its "pith" being very scanty comes out in a string from the centre. The end is cut in the slanting direction. Enquiry has shown that this material is not indigenous but an exotic from China.

Another kind—hollow, hard and more durable than the above two—seems to be produced from a species of bamboo and is also an exotic from China. It is often used by the Bombay merchants. In Gujrat and Kathiawar people also use the culms of *Pharagmites karka*, Trin., locally known as *Achhni* Gujrati).

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Pens are also made in the Haveri taluka of the Dharwar District from the midrib of the leaflets of *Caryota urens*, Jacq., locally known as *Bagani galagu* (Canarese).

The pen fern from the Darjeeling District in Bengal is *Gleichenia linearis*, Bedd.

Pens are sometimes made of thin jowari stalks when reeds are not easily available. Being soft and pithy they soon wear away.

Pens are also made of porcupine quills. The use of the quill feathers of birds which is slowly disappearing is an old indigenous practice.—(G. B. PATVARDHAN.)

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ANNATTO.—Annatto is employed as a dye for calico, silk, wool, skins, feather, ivory and bone and in colouring butter and cheese. It produces a fast colour of both yellow and red tints. The plant (*Bixa Orellana*) is a native of West Indies and other parts of tropical America.

It is a shrub or small tree of very branching habit of growth and attains a height of 8 to 12 feet. It is a hardy plant and fruits very freely in the plains of India in any ordinary soil and climate.

The fruit is a capsule which, when ripe, splits into two valves, on the inside of which are attached seeds covered with a thin coating of reddish waxy pulp. This waxy substance contains the colouring matter known as Annatto.

The dye is extensively used for colouring butter and cheese in nearly all countries, for which purpose in India the seeds are ground to a fine powder and soaked in pure olive, sessamum or safflower oil. The extract is then strained through fine muslins.

The plant is propagated from seed which should be sown in a shaded nursery. When the seedlings are about four months old, at which time they should be 6 to 8 inches high, they should be transplanted about 12 feet apart, if the soil is good. Pits should be dug out to a depth and diameter of 18 inches for each seedling.

Fair crops may be expected in three or four years, but it takes longer to get a fully established plantation.

In India the plant has been grown chiefly in Government gardens. It is a plant of considerable economic value and should be more widely cultivated.

The seeds, when ripe, should be extracted from the capsules and dried in the sun. They may then be steeped in very hot water. By stirring, the waxy testa is then washed off from each seed. After some days the whole mass should be strained. The liquid should be allowed to ferment for a week and then the dye matter settles. The clear water should then be poured off, and the dye dried in shallow pans. When the substance is semi-hard, it may be moulded into rolls, wrapped in Banana leaves, and then becomes the ordinary Annatto of commerce.

In Jamaica, Annatto is an important export, almost entirely produced by the peasant class. These exports are increasing and go chiefly to the United States.—(EDITOR.)

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INDIAN SUGAR INDUSTRY.—The Bombay Department of Agriculture have lately issued a leaflet about the relative profits of making *Gur* (crude sugar) and of making refined sugar by the Hadi process. It shows that in the present conditions prevailing in the Poona District it pays far better to make *Gur* than to manufacture sugar. The initial cost and recurring expenses for upkeep of the plant required in Bombay for *Gur*-making is much less than that required for the Hadi process. The net profit per acre of cane made into *Gur* was also found to be larger. The reason is that *Gur* in Bombay commands in most seasons a high market rate because it is suitable for certain kinds of Indian sweetmeats and cookery.—(EDITOR.)

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NEW PLOUGH FOR SIND.—On the Mirpurkhas Farm the following form of wooden plough has been found to do very good work. It is a slight modification of the indigenous wooden plough of Egypt. With perennial irrigation, where the land

can always be softened by water, it is a most efficient implement. Along with the leveller or "ghasabiah" it forms practically the whole stock-in-trade of the Egyptian cultivator. It has there held its place in the estimation of the cultivator against repeated attempts to introduce iron ploughs. The broad share deals effectively with weeds. The sharp-pointed Sindhi plough, on the contrary, is very apt to miss a considerable number of these, and in particular often fails to pull up the very troublesome creeping stems of "kull" and other plants.

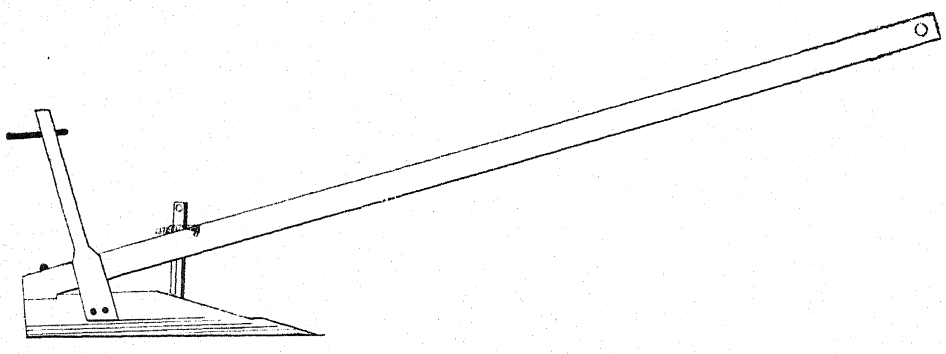

FIG. 4.

Construction.—The pole is made of jarrah or any long grained wood and should be about 11 feet long and 4 inches broad and 2½ inches thick. The body is of babul wood, about 3 feet 6 inches long. The body and pole are dove-tailed into each other and fastened by a moveable bolt. The handle is fastened to both ends of the body, leaving the pole free to move on removal of bolt. Half way along the body an iron bar is fastened through the body, and goes through the pole. At the top of the iron are several holes by means of which the angle between body and pole can be regulated. The share is 6½ inches broad and spear-shaped, being fastened to end of body. The total cost of construction, including labour and material, is between Rs. 7 and Rs. 8.

Demonstrations of this implement are being arranged to be held in each Taluka town, when a sufficient supply of implements has been made.

Ridging.—For ridging up land a piece of wood of the following shape is inserted behind the iron bar :—

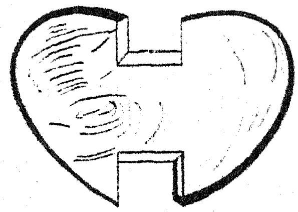

FIG. 5.

General Use.—The cost of ridging with the plough is very considerably cheaper than the same work done by hand with the "kodar." With a couple of ploughings, any land should be in sufficiently good tilth for ridging up. It is essential for the proper growth of Egyptian cotton and all other crops that the land must be in good tilth and properly cultivated, and this can be done probably better by means of this plough, than by employing an expensive English iron one. It has an advantage over the latter, in that the cultivator takes to it naturally. He has no difficulty in holding it, as he has with the two-handled plough. On the other hand, there are several makes of light one-handled iron ploughs having wooden poles. These have, however, been found quite unsuitable for this class or hard soil, it being almost impossible to keep them in the ground.

In comparison with the Sindhi plough, though slightly heavier in draught, it will do a half more work and go a couple of inches deeper. The dimensions given above were adopted for ploughs worked by cattle of the Cutchi or Guzerati type. The sizes may, however, be varied to suit smaller cattle.—(G. S. HENDERSON.)

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THE BENGAL AGRICULTURAL COLLEGE.—On Monday, August 17th, His Honour Sir Andrew Fraser, Lieutenant-Governor of Bengal, laid the foundation-stone of the Bengal Agricultural College. The occasion was a noteworthy one, marking as it does urther advance in the policy of agricultural development

inaugurated under Lord Curzon's régime and in the scheme of Provincial Colleges for agricultural education and research, throughout India.

The Bengal College is not the furthest advanced of these, although at the time of the foundation-stone ceremony it was well above plinth level. It is, however, hoped that it will soon be complete for the reception of students.

Meanwhile the European staff, consisting of the Principal of the College who will have charge of the agricultural section and will control the general work of the College, is on the spot. The Economic Botanist and the Agricultural Chemist are also already at work in temporary laboratories, and doubtless will take in hand the planning and fitting of their permanent laboratories and such preliminary investigations in their respective lines of work as may be possible. The Principal is gaining local knowledge as to the ways and means of practical agriculture in Bengal and is laying out his College farm.

The College is charmingly situated on an elevated site at Sabaur, about five miles from Bhagalpur. Three hundred acres of land have been acquired, 170 of which will be devoted to farm purposes, and the remainder for the College and other necessary buildings and for a garden of plants of economic value in Bengal.

The East Indian Railway runs through the property which is thus extremely easy of access.

As an experimental and demonstration farm, the site selected leaves little to be desired, providing as it does conditions of soil and climate under which almost any crop typical of the plains portion of the province may be grown with average rainfall helped by irrigation from wells which can be profitably arranged for.

The function of the College will be similar to that of the other provincial institutions throughout the country. It will provide a centre where the many scientific problems affecting agriculture in Bengal may be investigated and from which the practical results of such investigations may be disseminated amongst the people, whilst, at the same time, providing that grounding in general agricultural education and the cultivation of

the scientific habit of mind, which are so essential to a proper appreciation and utilisation of such knowledge.

It has been wisely recognised by Government that the problem of agricultural improvement as it affects the whole of India is too vast a one to be dealt with at any one institution, however fully staffed and equipped it might be. Apart from the educational aspect of the matter, which can obviously only be dealt with under local conditions, it is in the highest degree advisable that the work of investigation should be carried out all over the country so that problems of local importance may receive adequate treatment. A central institution such as Pusa provides, can then perform the necessary function of co-ordinating the various results obtained and advising the application of knowledge gained in one quarter elsewhere, whilst simultaneously performing its main function of conducting research on problems of general application to India. The relative position which should exist between the provincial institutions and the central one was aptly expressed by Mr. W. R Gourlay, the Bengal Director of Agriculture, in the speech in which he opened the proceedings at Sabaur. In the course of explaining how it was found that although Pusa was situated in Bengal it would not meet the needs of the province either in the matter of research or of education, he said :—" It was recognised that Pusa must be an international institution whose main object is research, and that it would be unwise to hamper the Imperial experts with the duty of elementary teaching. Their undivided attention must be given to solving the greater problems of agriculture so far as they affect the whole of India, and whatever teaching is undertaken by them must be of an advanced nature with a view to training the best graduates of the Provincial Colleges to hold the highest positions in the Indian Agricultural Service, so that in time India will require few experts from outside."

It is hoped to attract the sons and agents of the Zamindars and the members of the hereditary cultivating classes of Bengal to the college at Sabaur and to work through them to the ryot and to all sections of the agricultural community. Again, to

quote Mr. Gourlay: "An Agricultural Department in India differs from a similar organisation in Western countries, in that the latter is the outcome of the spontaneous demand of the cultivators, while the former has been created from above, and the gap between the department and the people to benefit whom it has been created has to be bridged. The Agricultural College is the main arch of this bridge and the Agricultural Associations are its buttresses. The natural sequence of the department will first be research and experiment and then demonstration to the people; while research and experiment are being carried on, the training of the men to carry the results to the people will be done at the College, and we hope to train in this institution men who will go forth to every district of the province equipped with a scientific and practical knowledge of agriculture. These men will form the centre from which the achievements of the departments for the benefit of the cultivator will be spread far and wide throughout the land. We look forward in time to having one such expert in every sub-division surrounded by an agricultural association of all the best cultivators of the country."

If these hopes are realised, then the foundation of the Agricultural College at Sabaur will indeed "prove a land-mark in the advance of the welfare of the cultivator in Bengal."—(C. J. Bergtheil.)

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Cardamom Cultivation in South Mysore.—Mr. D. J. Evers is the writer of an interesting article on this subject in the November number of the *Indian Forester*. Various kinds grow luxuriantly, particularly in moist places in the Forest ghats of the Mansarabad and Belar Taluka of the Hassan District. The plant is said not to thrive on Southern and Western exposures. It comes up spontaneously in the ghat forests when light is admitted by the felling of some large trees. The general belief is that the seed which induces such growth is disseminated by monkeys and rats. The cultivation by some planters is considerable; nearly all coffee estates have fair-sized areas under this crop on partially cleared forest land.

There are two methods of cultivation : (*a*) the method adopted by Brook-Mockett and Middleton, the two largest planters, and (*b*) the Coorg system. In the former the forest is thinned out to admit sufficient light, and nursery-raised seedlings are used to plant out the cleared area. The crop begins to yield in the third or fourth year and is in full bearing in the fifth or sixth. Irrigation, if available, is useful at some seasons ; weeding is required. In the Coorg system, small detached areas on which the plant has come up naturally are carefully selected. In February-March, small trees, two to three feet in girth, and brushwood are cleared. The forest leaf canopy should not be too dense, and it may be necessary to fell one or two large trees across each plot. The seedlings make their appearance soon after the first burst of the monsoon and by the close are three or four inches high. At the beginning of the following monsoon, they are thinned out where overcrowded and vacant spaces are stocked. The plants yield in the fourth or fifth year according to the richness of the soil. They continue to produce good crops till the fourteenth year, when they begin to decline and die. Then the soil has to be renovated by felling one or two big trees across each small plot. The Coorg system does least harm in the clearing of valuable trees.

There are two methods of drying the produce, (*a*) spreading it on mats or in trays and exposing it to the sun, and (*b*) drying it over a slow fire. The oven is a long, brick and mud structure, the roof of which is either flat and formed of zinc sheeting or a hollowed-out trough. The fruit is spread over the oven until sufficiently dry. After the fruit is dried, the stalks are cut off and the produce is ready for sale. Cardamom is largely sold locally and in winter a class of people called *Beries*, from South Canara, buy up large quantities. The Hindus pickle the tender green fruit ; when dry, it is much used in confectionery. In Coorg, the Forest Department cultivate cardamom.—(EDITOR.)

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OPIUM IN PERSIA.—The cultivation of opium in Persia has, within the last twenty years, spread from the Provinces of Jezd,

Kerman and Ispahan over the whole country, and now occupies a considerable area which was formerly devoted to wheat. There is an increased consumption among 20 per cent. of the population. The crude opium is collected from the capsules in the common Indian way.

For home consumption as well as for export, it is boiled down by slow fire and extensively mixed with various ingredients which include grape juice, wild rue (*Ruta sylvistris*) and sarcocolla, a resin of *Panæ mucronata.*

The export trade is increasing and the whole trade is very considerable, but no definite statistics are available.—(EDITOR.)

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POPPY CULTIVATION IN AFGHANISTAN.—Poppy has apparently begun to be extensively cultivated in Afghanistan. In 1906-7, Afghan opium was first imported into the Punjab through Peshawar to the extent of 125 cwt. The quality is reported to suit the taste of consumers, and to some extent this opium takes the place of Malwa opium. The traders who have dealt hitherto in Malwa opium have probably found in Afghan opium a good paying article of which they can push the sale; and the imposition of adequate taxation upon it may be a matter of importance before a large trade develops.—(EDITOR.)

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WELL-BORING.—Mr. Alfred Chatterton, Director of Industries, Madras, and author of the well-known work on *Lift Irrigation*, has sent to the Press the following interesting note on the subject of well-boring:—

"When the construction of a well is undertaken, there is almost always some uncertainty regarding the volume of the water-supply that will be obtained. This is due to the fact that what lies below the surface of the ground is always more or less a matter of conjecture. In some cases our knowledge of the subsoil is sufficient to render the risks of well-sinking of no practical importance, but in the majority of cases it is otherwise, and a preliminary examination of the ground, if it can be made at

comparatively small expense, is of distinct advantage. This can be done by boring or jumping a hole of small diameter to such depth as is necessary with the aid of specially constructed tools. The material removed from the hole affords information as to the nature of the strata through which the well will pass, and this information, studied in the light of the experience which has accumulated from the sinking of many thousands of wells, enables us to form a fairly accurate idea as to the quantity of the water likely to be obtained. Where the subsoil is soft or sandy, the hole must be provided with an iron liner to prevent it from filling up as fast as it is made, but where the hole is in stiff clay or rock, the boring work can be done without any such artificial support.

" In a brief note it is impossible to describe in detail the tools employed, but it is not difficult to explain the principle upon which they work. Just as a hole is bored in wood by means of an auger or bit, so through the soft strata of alluvial deposits holes can be driven by similar tools of much larger dimensions. As the auger consists of a handle, a shank and the cutting edge, so the boring tools are similarly constructed. Various types of auger head are used and these can be screwed to steel rods which are usually 10 feet long and as many as are necessary are employed to reach from the surface of the ground to the bottom of the bore hole. At the top there is a swivel head by which the rods can be lifted and the handle of the auger is formed by clamping iron levers to the boring rod at a convenient height above the ground, so that men by walking round in a circle can rotate the auger. When the material to be bored through is fairly stiff, the auger takes the form of a worm or an open shell, and from time to time it has to be lifted from the hole to remove the clay which has gradually worked into it. When the soil is of a loose character, the auger has to be fitted with a shell above to hold the material removed by the cutting edge, otherwise it will fall back into the hole whilst lifting the auger to clean it. These shell augers are fitted with various shapes of cutting edges depending upon the nature of the material to be removed, which

may vary from fine sand to soft sandstone. When hard rock has to be pierced, rotary tools worked by hand are not effective, as the speed of working is too slow and recourse must be had to the percussive action of variously shaped chisels for the breaking of the rock. The chisel is attached to the boring rods and a heavy blow is given by lifting them a few inches and allowing them to drop. Care must be taken to slowly turn the boring rods so that each blow of the chisel falls on a different diameter in the bore-hole. When the chisel has pulverized a sufficient quantity of rock, it is withdrawn from the hole and a plain shell lowered which collects the mud when it is rapidly jerked up and down in the water at the bottom of the hole. To work a set of boring tools it is necessary to have a derrick which may be conveniently made of 4 casuarina poles about 25 feet long. At the top of the derrick is fastened a pulley over which the lifting rope passes from the swivel head to the winch. This latter may be attached to two legs of the derrick and should have a lifting capacity of at least 2 tons. Besides the chisels and augers there are a great variety of tools which can be attached to the boring rods, most of which are ingenious devices for removing broken tools from the hole.

"As the hole proceeds through soft material, lining tubes must descend with it, and this is usually effected by rotating them, their own weight being sufficient to make them descend. If the pipes stick badly, a suitable cap must be placed on the top and the methods commonly employed in pile driving resorted to. If the lining tube has to pass through a layer of stiff clay, the work is often facilitated by rymering the hole bored out by the auger to a larger size. If it is not intended to bore holes to a greater depth than 50 feet, a set of tools working a 3-inch liner will be a convenient size to employ, but if the holes are to run to a depth of 100 feet or more, the diameter of the lining tube should be at least 4 inches.

"Where it is known that artesian or sub-artesian water exists, it is necessary to use pipes of much larger diameter if it is desired to obtain an abundant supply of water.

"Well-boring has been developed in the French territory of Pondicherry much more extensively than in any part of the Madras Presidency, and it is possible to procure sets of boring tools from the blacksmiths in Pondicherry at very reasonable rates. They do not, however, supply the tools necessary for withdrawing the lining pipes and the sets are therefore not convenient for exploratory work, as in such work the lining tubes are usually removed from the holes as soon as the necessary information has been obtained. Messrs. Burn and Co., of Howrah, supply suitable sets of tools. A set with lining tubes to bore a hole to a depth of 50 feet costs about Rs. 700 delivered in Madras, whilst a 4-inches set of tools with lining pipes costs about Rs. 1,100. Considerable experience is required to make satisfactory use of a set of boring tools, and difficulties and obstructions frequently occur which can only be dealt with by men experienced in such work. In boring, the tools are subjected to rough usage and repairs are frequently found necessary. It is therefore desirable to have a fair number of duplicate parts, so that the work of boring need not be stopped while repairs are being effected.

"The cost of boring varies considerably, depending not only upon the diameter of the borehole and its depth, but also upon the character of the soils or rocks pierced. In the alluvial deposits along the Coast in the Chingleput District where some 400 boreholes have been put down, the average cost for a 3-inch borehole is about 4 annas a foot up to a depth of 20 feet, thence on to 40 feet it costs 6 annas a foot, and beyond that up to 60 feet, 12 annas a foot; from 60 to 70 feet the cost is Re. 1 a foot and from 70 to 80 feet Rs. 1-4-0 a foot. Beyond this depth only a few borings have been made and the cost of the work done has varied considerably. These rates, it should be pointed out, do not include the cost of carrying the tools from one place to another. This is a small item when many holes are to be put down in one neighbourhood, but becomes of importance when the tools have to be carried a long distance to bore a single hole.

"The principal sources from which subterranean water can be derived are beds of sand and rock which is highly fissured or partially decomposed. By putting down a borehole, information on these points can be obtained and the exact depth at which the water-bearing strata is met with can be easily determined, or its absence definitely ascertained. Sometimes in fissures the water exists under pressure, and a borehole from the bottom of an existing well tapping a fissure will often deliver considerable quantities of water into the well from which it can be removed either by baling or by pumping. Along certain parts of the Coast, beds of sand are found enclosed between impervious beds of clay. Some of these are of considerable extent and thickness, and they contain water under pressure. Boreholes penetrating the upper impervious layer enable the water to rise to its static level and, when this is above the ground, flow takes place and the supply is termed artesian. More frequently the static level is below ground level and the water can only be obtained by sinking a well round the borehole to a few feet below the static level. Water will then flow into the well and can be removed by baling or pumping. If the borehole is made sufficiently large, a suction pipe or pump may be put down the hole and the water drawn off by lowering the static level in the borehole itself. Ordinarily, however, borings do not penetrate artesian basins, and the character of the water-supply likely to be derived from sinking a well must be determined by an examination of the materials through which the borehole has passed. Gravels usually yield water most abundantly, then coarse sand, and lastly, fine sand. When the sand is coarse, or the water-supply is derived from gravel, a well of small diameter will generally yield a large quantity of water, but when the sand is very fine, a well of large diameter is required to obtain a large supply of water, and that again is only possible when the bed of sand is of considerable thickness. When the borehole has passed through rock and the chisels have to be used, no very definite information can be gained from an examination of the material brought out of the borehole, but by putting a tube well pump down the borehole, and exhaust-

ing the water we can ascertain the rate of the inflow from the surrounding rock into the borehole under a given pressure. Apart from fissures, this enables a rough estimate to be formed as to the water-yielding capacity of the rock.

"The experience so far gained in the South of India is undoubtedly to the effect that large supplies of water are generally only to be obtained from beds of sand or gravel, but occasionally wells in fissured rock yield an abundant supply of water, whilst percolation wells in porous or decomposed rock seldom yield more than moderate quantities of water. That is to say, they may yield 3,000 or 4,000 gallons of water per hour, but not 10,000 or 12,000. So far the largest supply of water derived from any single well in the South of India is 45,000 gallons per hour. This is not, however, the limit of the capacity of the well, but that of the pump working on it. During the last year or two, oil engines and pumps have been installed in many places to lift water for irrigation, and the size most commonly employed is a 4″ pump which will deliver sufficient water for from 20 to 25 acres. This is equivalent to from 18,000 to 20,000 gallons of water per hour, and although there are few indigenous wells which will yield this supply, it has not been found difficult to obtain it from wells sunk after a preliminary investigation of the ground has been made by the use of boring tools. There is undoubtedly a vast amount of subterranean water which has never yet been made use of, and to locate it definitely boring tools must be used."

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PAPER PULP.—The samples of paper, prepared mainly from megass, exhibited at recent meetings of the Trinidad Agricultural Society, give promise of an important subsidiary industry in connection with cane-growing.

These samples have been made at the Tacarigua Factory by a process of which the Proprietor, Mr. Bert de Lamarre, is the originator.

Various kinds of wrapping paper have since been produced, but the bleaching experiments are still in progress.

It is expected that for every ton of sugar a ton of megass will be available. This works out to an average of about 50,000 tons yearly for this Colony.

Allowing 20 per cent. for moisture and waste, there should be a balance of 40,000 tons of fibrous material suitable for making paper.

Samples of this paper are exhibited at the Victoria Institute. —(BULLETIN NO. 60 OF MISCELLANEOUS INFORMATION, TRINIDAD.)

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DATE PALM CULTIVATION.—In February 1908, seven date palms in the Central Jail, Trichinopoly, came into flower, and three of them bore fruit. These palms are the product of Muscat dates. The seeds were sown in pits dug three feet cube and well watered. They germinated in about 20 days. The ground was neither cultivated nor manured. In February 1907 three palms came into flower, two males and one female. For want of artificial fertilisation, the fruit set imperfectly and dropped. In February 1908, these three palms again flowered with four new ones, two males and two females, when Mr. H. C. Sampson, Deputy Director of Agriculture, Madras, showed me how to use the pollen by tying up a branch of male flowers over a female inflorescence. On the two artificially fertilised trees, the fruits set and came to maturity in fairly large quantities; in the third (not artificially fertilised) the fruit set in great profusion, but did not ripen and had no seed. Of the three trees that bore fruit, two were of one variety and bore long golden coloured dates. The third tree bore crimson fruit which turned brown when ripe.

At Boce camp, about one mile from the Central Jail, there are several hundreds of date trees. The dates are the favourite food of the Boces. These palms look strong and healthy even without cultivation and watering; their seeds were not sown, and the stones grew where the Boces had spat them. The Boces left in 1902, and the date palms are now flourishing at the camp. Some of them are well grown enough to flower and are undoubtedly very hardy; inside the Jail none has died.

A curious fungus attacks the leaves, but apparently does no harm : a few trees were attacked and damaged by boring beetles ; when the fruit was ripening, ants infested the branches which had to be protected by linen bags.

Stones of both varieties have been collected from the ripe fruit and sown ; the young plants from them now look healthy. Stones of both varieties were sent to the Central Jails at Coimbatore, Vellore and Bellary ; and those sent to Vellore are reported by the Superintendent to have germinated.—(R. SHUBRICK.)

REVIEWS.

Agricultural Education in England and Wales.*

The Minutes of Evidence taken before the Departmental Committee appointed by the Board of Agriculture and Fisheries to enquire into and report upon the existing facilities for affording scientific and technical instruction in England and Wales, which has just been published as a Blue Book extending to over 600 pp., contains a mass of information on almost every branch of agricultural education. The President of the Committee was Lord Reay, formerly Governor of Bombay; in the course of thirty-one sittings held between April 1907 and February 1908, one hundred and thirteen witnesses were examined, and among these were Heads of Universities, Principals and Professors of Agricultural and other Colleges, Experts in the various branches of applied science pertaining to agriculture, Government Officials, and Colonial Representatives. Of these last, two were from India, Mr. H. S. Lawrence, Director of Agriculture, Bombay, and Mr. W. H. Moreland, C.I.E., Director of the Department of Land Records and Agriculture in the United Provinces.

It is impossible to refer, in order, to the various subjects which came up for enquiry or to compress the evidence tendered before the Committee in the course of a brief review. We merely indicate a few salient points in the evidence given by the Indian witnesses, and refer incidentally to the progress of

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*Minutes of Evidence taken before the Department[illegible]ommittee appointed by the Board of Ag[illegible]ture and Fish[illegible] to enquire into and report upon the subject of Agricultural Educa[illegible]land [illegible]d Index. Printed by McCorquodale & Co., Ld., London.

agricultural education in one or two foreign countries about which some interesting information was elicited by the Committee.

Mr. Lawrence was the first Indian witness who was called in, and in the course of his evidence he pointed out, as showing the importance which the Government of India attach to agricultural education, that every officer of the Bombay Civil Service was now required, within the first year of his service, to study the elementary problems of Indian agriculture during a short stay at Poona, and that officers who were appointed as Directors of Agriculture were encouraged to go to England in order to attend some of the courses at the higher agricultural colleges there. The establishment of a readership in tropical agriculture in one or more of the British Universities, he stated, would enable such officers to benefit by their course. This was a suggestion that had emanated from Dr. Barber, the Government Botanist of Madras, and Mr. Lawrence considered it an admirable one, if it was possible to obtain for the readership one with experience of agriculture in a tropical country. Prof. Middleton, Assistant Secretary to the Board of Agriculture and Fisheries, pointed out that the expense of subsidising such a chair would be about three or four hundred pounds. If other tropical countries, such as Ceylon or the West Indies, who would also be benefited by the establishment of the readership, could co-operate and agree to a distribution of the expense, the proposal is certainly within the bounds of practicability. Mr. Lawrence then gave the Committee a brief historical sketch of the constitution of the Imperial and Provincial Departments of Agriculture in India, with detailed information relating to the work carried on in the Bombay Presidency.

Mr. P. J. Mead, Acting Director of Agriculture, Bombay, submitted a few supplementary notes to the Committee, in which he urged, among other things, the desirability of giving to th European experts now in India opportunities of keeping t knowledge up-to-date. If they could periodically be "study leave" and could add to ... sent of Indian conditions, a knowledge ... e since b ... ll in progr

centres of scientific research, their usefulness would, he considered, be greatly increased.

The evidence of Mr. Moreland was mostly in connection with the working of the Co-operative Credit movement in India. The only other subject on which he tendered evidence was in the matter of the control of agricultural education. He stated that its *control* should be entirely under the Agricultural Department, and that the Educational Department should merely advise and assist when necessary. He submitted to the Committee a Memorandum stating the reasons why the Cawnpore Agricultural College was placed under the control of the Agricultural Department.

Perhaps, the most interesting evidence was that given by Professor Middleton. He strongly advocated the study of practice in agriculture before the completion of the course of theoretical study. He stated that what the agricultural student wanted was information on which he could depend, and if provision could be made for what the agricultural student asked for and required, students would be coming forward in increasing numbers to acquire that knowledge so that they may utilise it. He gave detailed information of his own career to illustrate the kind of education which he wished imparted to students. As a boy he was brought up upon a farm, his father having been a tenant farmer. He received his school education in Edinburgh. After leaving school he went almost as a matter of course to a Scotch University. He graduated at the age of 19, and then he went back to farming. His intention was to farm in Scotland. He had occasion to carry out, in connection with the Highland and Agricultural Society, a number of demonstration plots. He became very much interested in this type of work, and he saw that if he was to get any direct advantage from science as a farmer, he must get more first hand information about science. He therefore went back to the University of Edinburgh, and found that he could now learn more in a month than he could previously have done in two or three. He then got an offer of an appointment in India, and the credit of organising the Department of Agriculture

in an Indian college, the first of its kind in connection with an Indian University, is due to him. After six and a half years' stay in this country, he went back as Lecturer in Agriculture to Aberystwyth, where he was for about three years. He went from there to the Armstrong College, then the Durham College of Science, for about three years. He has been for rather more than five years Professor of Agriculture in the University of Cambridge, and recently took over the appointment of Assistant Secretary to the Board of Agriculture and Fisheries. Lord Barnard, who was in the chair, observed that, in his judgment, Mr. Middleton's career exactly illustrated the type of student whose future they ought to have very distinctly before them in considering the Report they had to make.

Prof. Middleton then gave some interesting information about the types of agricultural education in a few foreign countries which he had seen, and of which he had read. He also gave a sketch of the development of the Department of Agriculture at Cambridge.

Referring to the kingdom of Saxony, which is one of the richest agricultural countries in the German Empire, he stated that the University of Leipsic had an agricultural department where nearly 350 students were studying agriculture during the winter and summer terms. There was also a Forest school, a Veterinary college, and 15 agricultual schools of varying grades. In Prussia, there were five University Departments of Agriculture, two colleges quite of University rank, two colleges for forestry, 2 Veterinary colleges, and 16 high-class Agricultural schools. There were besides 22 lower-grade agricultural schools, 138 winter schools, and 177 special schools dealing with such subjects as dairying, farriery, horticulture and domestic economy. The Berlin Institute, he observed, was the finest of its kind in Europe, being perfectly equipped for the teaching of agriculture. It cost the State something like £27,000 a year, and it received in fees and from other sources about £9,000 a year. What struck him very much in the type of education prevalent on the continent was the extent to which not only Government but

agricultural societies took up agricultural education and research. Agricultural societies not only subsidised Experimental Stations, but they employed teachers, always well-qualified teachers sometimes associated with central institutions, sometimes with small local institutions, and sometimes itinerant teachers who went about giving advice to members of the society. These teachers, though not "practical" men in the English sense of the term, had got to go through a prolonged course and pass an examination, and in Prussia they required at least one year's agriculture before they were qualified. In addition to these institutions for the teaching of agriculture, there were in Germany about 76 Experiment Stations, of which 46 were in Prussia and 5 in Saxony. All the agricultural institutions were connected with different states. But there was one institution at least for the whole German Empire which was of the greatest importance to agriculturists, and that was a new Institute established in Berlin for the purpose of investigating the diseases of agricultural and forest crops.

Turning to the United States of America, Prof. Middleton stated that there was first of all a Central Department of Agriculture at Washington which was partly administrative, but which *primarily* existed for the purposes of research. The funds available for this Central department were over a million pounds sterling per annum. The Divisions of the United States Department of Agriculture were the Weather Bureau, the Department of Animal Industry, the Bureau of Plant Industry, Forest Service, Bureau of Soils, Bureau of Chemistry, Bureau of Statistics, Bureau of Entomology and the Bureau of Biological Survey, the Office of Public Roads and the Office of Experiment Stations. The last had charge of educational work and publications, its most important publication being *The Experiment Station Record*, published monthly, which consisted of an abstract of all the work on agriculture which had been done in every part of the world. His own interest in the *Record*, Prof. Middleton stated, began in India. He used it from the beginning, and found it particularly valuable to him, because it brought him

into contact with the work in the Southern States of America which was similar to the work carried on in India in cotton and tobacco growing. Each of the American States, with one or two unimportant exceptions, possessed at least two institutions for the promotion of agriculture or agricultural education; one was the Land Grant College, and the other the Experiment Station. The leading object of the Land Grant College was to teach such branches of learning as were related to agriculture and the mechanical arts, including engineering, etc. The idea was to make them useful as professional colleges for the people of the United States. In 1904, there were 2,700 teachers in these Colleges and 56,000 students. Of the students, 5,000 only were taking a four-years' course in agriculture, while about 6,000 were taking shorter courses. These Colleges, recognising the fact that the whole subject of agriculture was too wide a subject for one man, required of the students to specialise from the beginning in animal husbandry, or plant husbandry, or some other department of agriculture or horticulture. The University and College education of the United States have only become successful since the Experiment Stations began their work, and since the results of the work permeated the Colleges.*

Turning to India, Prof. Middleton stated that, during recent years, very great progress had been made, as the result of the scheme laid down by the Government of India for the expansion of the Departments of Agriculture. In pursuance of this policy, the Imperial Agricultural Research Institute at Pusa was established and every Province has now an institution for agricultural education, in addition to Experiment Stations for research. All these were founded and paid for by Government, excepting the Tata Institute which was the outcome of private munificence.

We must conclude this very inadequate review by repeating that the volume is full of information of interest to all concerned with agricultural education.—(C. S. RAGHUNATHA RAO.)

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* More detailed information about the Land Grant Colleges and the agricultural work in the United States of America, will be found in Mr. Harwood's excellent book, entitled *The New Earth*, published by Messrs. Macmillan & Co.

UNTERSUCHUNGEN UBER NITRIFIKATION. (INAUGURAL-DISSERTATION ZUR ERLANGUNG DER DOKTORWURDE DER HOHEN PHILOSOPHISCHEN FAKULTAT DER GEORG-AUGUSTUS-UNIVERSITAT ZU GOTTINGEN—BY LESLIE C. COLEMAN.)

THE question of the influence of dissolved organic matter on the course of nitrification in soils has been one of the highest interest ever since Winogradsky isolated the nitrifying organisms in 1890 and showed that they did not require organic matter for their development. Nevertheless, remarkably little work has been done hitherto in the direction of its elucidation. The thesis before us is a contribution to this end and throws most valuable light on much that has hitherto been obscure.

In a paper published in 1899,* Winogradsky and Omelianski give the results of a number of experiments on the effect of dissolved organic substances on nitrification in artificial culture, from which they draw the conclusion that all such substances act as "antiseplika" towards nitrifying bacteria. In spite of its general acceptance, it has always been very doubtful whether this conclusion could be generally applied in considering what goes on in the soil, not only because we know that nitrification actually does proceed in soils containing considerable amounts of organic matter more or less dissolved in the soil water, but also because experiment has shown that the rate at which it proceeds, particularly during the first stages after the nitrifyable material is added, is more rapid in soils of high humus-content than in those in which the humus-content is low.† It has also been shown that the physical conditions under which nitrification takes place exert a considerable influence on the effect of dissolved organic matter on its progress, and the obvious difference between such conditions in artificial culture and in the soil has rendered it extremely doubtful whether Winogradsky and Omelianski's conclusion does not require considerable modification in order to be applicable to what occurs in nature.

* Centralbl. f. Bakt, &c., Abt. II, Bd. V, p. 329.

† Muntz and Laine, Compt. Rend. CXLII, 1906, p. 430.

The present author has, therefore, re-examined the whole question. In his earlier experiments, samples of soil taken direct from the field are treated with known quantities of ammonium sulphate and the organic substance under investigation and the rate of nitrification in various intervals of time determined and compared with precisely similar samples to which no organic substance has been added. Later, sterilised soil and sand are used as substrata, the necessary amount of ammonium sulphate added, and inoculations made with pure cultures of both nitrite and nitrate bacteria. The first and chief organic substance examined is dextrose. This substance had previously been shown by Bazarenski * to have a distinctly stimulating effect on nitrification and, therefore, presented itself as particularly interesting for investigation. Dr. Coleman shows definitely that dextrose, in quantities which, according to Winogradsky and Omelianski, stop nitrification entirely in culture solution, acts very beneficially in soil under normal conditions of temperature and moisture. This beneficial action is most apparent in the first two or three weeks, after which it declines and may eventually appear to be transformed into an inhibiting action, but it is shown that this apparent inhibition is actually due to denitrification which sets in more readily in the soils containing the dissolved organic substance. It is also shown that an excess of moisture, and the consequent partial or entire lack of aeration favours denitrification to such an extent that the beneficial effect of dextrose on nitrification may be entirely nullified even in the early stages. It seems clear that this accelerated action of denitrifying organisms explains the apparent inhibition of nitrification by dissolved organic matter in the latter stages of previous experiments in which soils, or substances of a similar physical nature, have been used as culturable substrata, and in the early stages of those experiments which have been conducted in liquid culture.

In the experiments with pure cultures of nitrite and nitrate bacteria, these results are confirmed, and it is further shown that

* Diss. Gottingen, 1906.

the beneficial action of dextrose is accompanied by a partial or complete disappearance of that substance.

The explanation of this stimulating action of dextrose is very fully discussed and examined, but no definite conclusion is arrived at. In the course of seeking for such explanation, a long series of experiments is carried out on the assimilation of carbon dioxide from the atmosphere by nitrifying bacteria and it is clearly shown that both the nitrate and nitrite organisms obtain their carbon initially in this way, but it seems extremely probable that in the latter stages it is derived from the CO_2 set free by the decomposition of the carbonates in the substratum by the acid produced. It is shown that dextrose cannot replace the CO_2 of the atmosphere as a source of carbon and the theory that it acts merely as a tonic stimulant (in a similar manner to that in which small quantities of poisons react on many forms of life) is rendered extremely improbable from the facts that the accelerated action is accompanied by a disappearance of the dextrose and that other nearly allied organic compounds do not produce a similar effect. It is true that the stimulating action might be induced by a decomposition product of the dextrose, but this is not indicated by the experiments on the action of calcium acetate and butyrate which the author describes, and it is difficult to imagine how such decomposition could take place in pure cultures. In this connection some experiments with alcohols and other compounds which are presumably intermediary between dextrose and the acid salts should be well worth making.

It is remarkable that both cane-sugar and lactose appear to have very little action on nitrification when added to soil. As Dr. Coleman points out, if the beneficial action of dextrose were due to its products of decomposition, we should expect a similar action from cane-sugar ; and the same thing might be anticipated from lactose but if, on the other hand, the sugars are inverted by micro-organisms, as the author surmises in the case of cane-sugar, surely we should expect the dextrose produced to exert the same action as it does when added direct to the soil.

None of the other non-nitrogenous organic substances experimented with seem to have any very appreciable action on the course of nitrification, whilst the nitrogenous ones have a distinctly inhibitory effect.

As a result of these considerations Dr. Coleman inclines to the opinion that dextrose acts as a source of energy to the nitrifying bacteria, which energy is expended in carrying out the oxidation of ammonia or nitrates as the case may be. But it is clear that much more work is required on the subject before a definite view can be expressed.

If dextrose acts merely as a source of energy to the nitrifying bacteria, other six-carbon sugars should have the same effect, and it would be of value in this connection to trace the action of levulose on nitrification in order to determine if the configuration of the dextrose molecule is of any specific importance in the matter. An effort should be made too to trace the changes which dextrose undergoes during the nitrification process: difficult though the task might be, owing to the small amounts of dextrose dealt with, it should not be unsurmountable if sufficiently large quantities of sand or soil are taken to start with.

At the conclusion of his paper, Dr. Coleman records some experiments on the influence of carbon disulphide on nitrification in soils. He finds, as others had found previously, that this substance at first leads to inhibition, but at later stages to a considerable acceleration of nitrification, and he ascribes the action to a direct stimulation of the nitrifying bacteria.

This matter is of particular interest in connection with the increase in fertility which has been shown by several investigators to take place in soils treated with CS_2 and other antiseptics. It would be of the highest interest to determine whether this increase in fertility is connected with a direct stimulation of the nitrifying bacteria or with the suppression of foreign bacteria in the soil to the advantage of those favouring fertility, perhaps the nitrifying organisms. In either case the increased oxygen absorption which Darbishire and Russell* have shown to accompany this

* Journal of Agricultural Science, Vol. II, p 305.

increase in fertility would presumably be apparent, but series of experiments on the action of antiseptics on nitrifying organisms in pure culture carried out in sterilised soil or sand should throw some light on the point.

It is extremely difficult to do justice to so detailed and excellent a piece of work as this of Dr. Coleman's in a short review. It is a type of what such work should be, lucid and full of suggestion for further investigation. It does the highest credit not only to its author but also to the German University system which makes the production of so valuable a contribution to knowledge incidental on the award of a degree.—(C. J. BERGTHEIL.)

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ANNUAL REPORT OF THE EMPRESS AND BUND GARDENS, POONA, FOR THE YEAR 1907-8.

IN the year under report the management of the Gardens continued to be efficient. The seed business was quite as extensive as in former years and the benefit of this trade extends to

ber of new plants of economic and

the stock of these gardens.

The fruit tree did not yield so well as in some former years owing to an unfavourable season. Over 400 new vines were planted. Vegetables are grown on a large scale.

The report under notice makes prominent mention of the successful use of the following remedies recommended by the Imperial Entomologist and Mycologist for the treatment of garden pests :—(1) Bordeaux mixture for checking the white fungoid disease of oranges and limes ; (2) Kerosine emulsion, soot and tobacco decoction for destroying cochchafers and caterpillars of various kinds ; and (3) tobacco powder for killing a kind of slugs that were eating up the bulbs of Eucharis lilies.

The experimental Botanical section is progressing well. The accounts for the year under report show a deficit of Rs. 116-12-11, but it is covered by the last year's balance of Rs. 2,493-7-4.—(EDITOR).

PUBLICATIONS OF THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA.

Annual Report of the Imperial Department of Agriculture in India for the year 1904-05. Price, As. 12 or 1*s.* 2*d.*

Report of the Imperial Department of Agriculture in India for the years 1905-06 and 1906-07. Price, As. 6 or 7*d.*

Proceedings of the Board of Agriculture in India, held at Pusa on the 6th January 1905 and following days (with Appendices).

Proceedings of the Board of Agriculture in India, held at Pusa on the 15th January 1906 and following days (with Appendices). Price, As. 12 or 1*s.* 2*d.*

Proceedings of the Board of Agriculture in India, held at Cawnpur on the 18th February 1907 and following days (with Appendices). Price, Re. 1-2 or 1*s.* 6*d.*

Proceedings of the Board of Agriculture in India, held at Pusa on the 17th February 1908 and following days (with Appendices). Price, As. 8 or 9*d.*

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ERRATUM.

Vol. IV, Part I, page 17, fifth line from bottom, *for* "tracts" [illegible] "trade."

PLATE VI

ERI SILK WORMS

Engraved and Printed by THE CALCUTTA PHOTOTYPE Co.

ERI OR CASTOR SILK.

By H. MAXWELL-LEFROY, M.A., F.Z.S., F.E.S.,

Imperial Entomologist, Pusa.

Eri silk is the cocoon of an insect known to science as *Attacus ricini* and probably the domesticated form of *Attacus cynthia* which is found in a wild state in Assam and along the outer forested slopes of the Himalayas. Eri silk is domesticated in the Assam valley, where it is grown for local use and, to a limited extent, for export. With Muga silk (*Antheræa assama*) it forms what is known in India as " Assam silk" as apart from Tusser and from mulberry silk.

At the present time, eri is not generally cultivated outside Eastern Bengal and Assam, Rungpur being about its western limit. During the past two years it has been experimentally grown at Pusa, and it is being grown also in other parts of India, from seed obtained from Pusa.

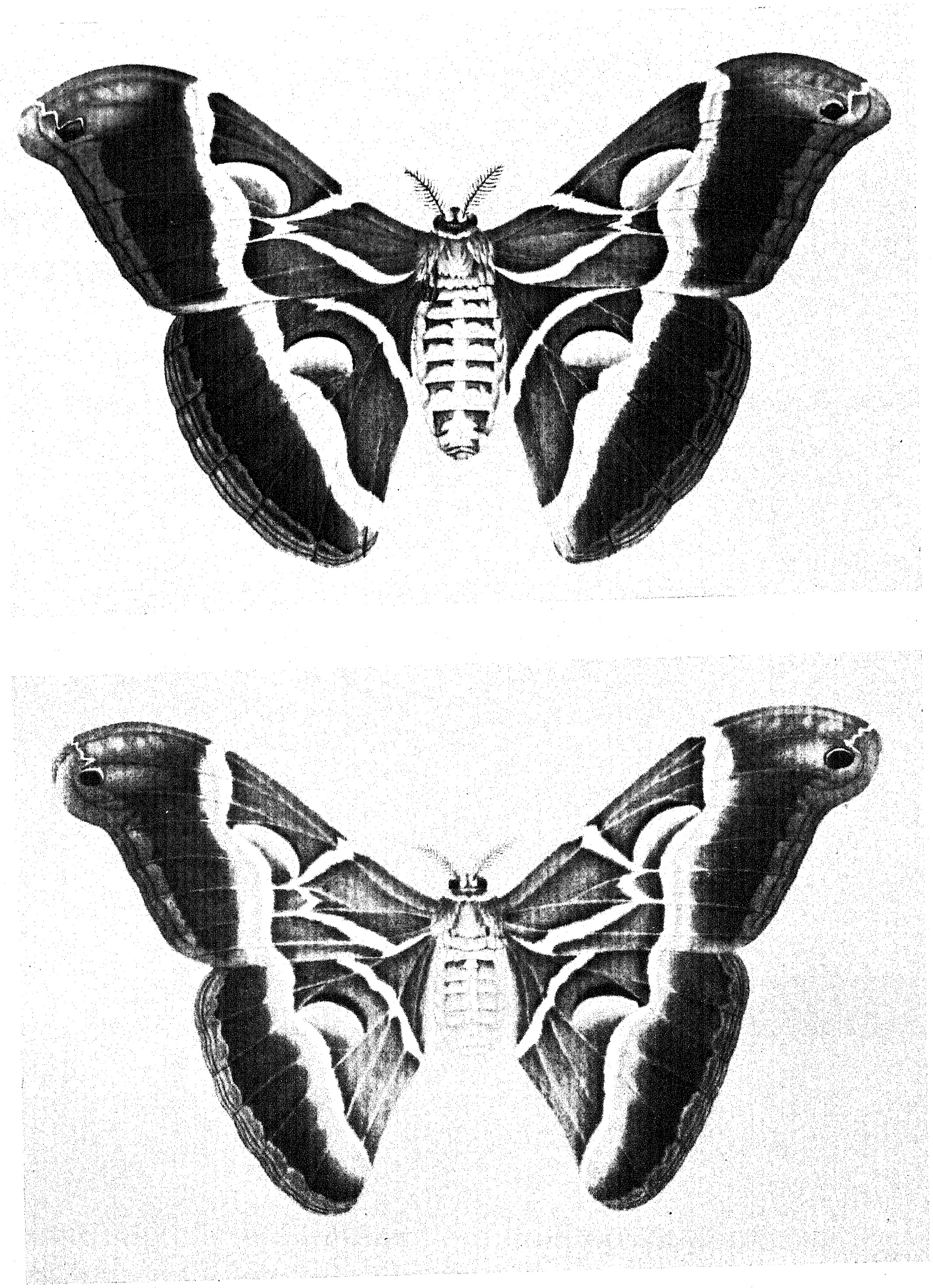
Eri silk has peculiarities which distinguish it from all other silks cultivated or collected in India. In the first place, the worms require only castor leaves for food; mulberry is not a food-plant. In the second, the cocoon is not a closed one and is not reelable in the same way as are mulberry or tusser silk cocoons; the caterpillar, in preparing the cocoon, leaves one end closed only with converging loops of silk, so that, while nothing can get in, the moth can push out; but the cocoon is made in layers, is not composed of a single thread and cannot be reeled by the ordinary process. On the other hand, the silk has this immense advantage, that the cocoons do not require to be "stifled," *i.e.*, killed, to prevent the egress of the moth; in preparing mulberry and tusser silk, the cocoon is killed, since the moth in getting out so damages

the cocoon that it cannot be reeled so well; in eri silk this is not so; the moth, as here utilised for spinning, must be allowed to emerge, and the taking of life, so abhorrent to many classes in India, is not necessary.

Another feature, shared with the "indigenous" mulberry silkworm, is the number of broods; seven or eight broods are obtained yearly, and as the production of eggs is large, a large brood can be secured from a small quantity of initial seed when castor is plentiful, and several crops of cocoons are obtainable yearly. The insect is completely domesticated in the sense that it will not run wild and become a pest; the whole life is passed in captivity, and the moths do not attempt to leave the rearing house. Rearing can be done in any building; the Pusa rearing has been done entirely in a grass and bamboo house (Plates VIII & IX). Lastly, the silk cocoons can be utilised just as cotton is, but yield a cloth far more durable and lasting; the cocoons are boiled, and then spun in the ordinary way that cotton is; the thread produced can be woven just as cotton thread is, and the cloth produced, while not so fine as machine-woven cotton cloth, is white, durable and much in demand. Dyed cloth is produced with ease by dyeing the cocoons, the thread or the cloth; and E. R. Watson has shown that silk is more easily dyed in fast colours with the ordinary indigenous dyes than is cotton, and that the dyeing of silk is easier than is the dyeing of cotton. With the indigenous and the synthetic (aniline) dyes, a great range of colours can be produced, and the dyeing offers no special difficulties.

We here discuss eri silk solely from one point of view, its rearing and utilisation in this country by ordinary indigenous methods suited to any part of India. The question of building up an industry in this silk for export or for utilisation in India with power machinery for turning out the beautiful spun silks of commerce, is not here touched on, nor is the kindred question of producing reeled silk from these cocoons. The work of the past two years has been directed to ascertaining how far this silk can be utilised in India, and it is our belief that silk of this kind can be grown, spun and woven in a very large part of India, almost

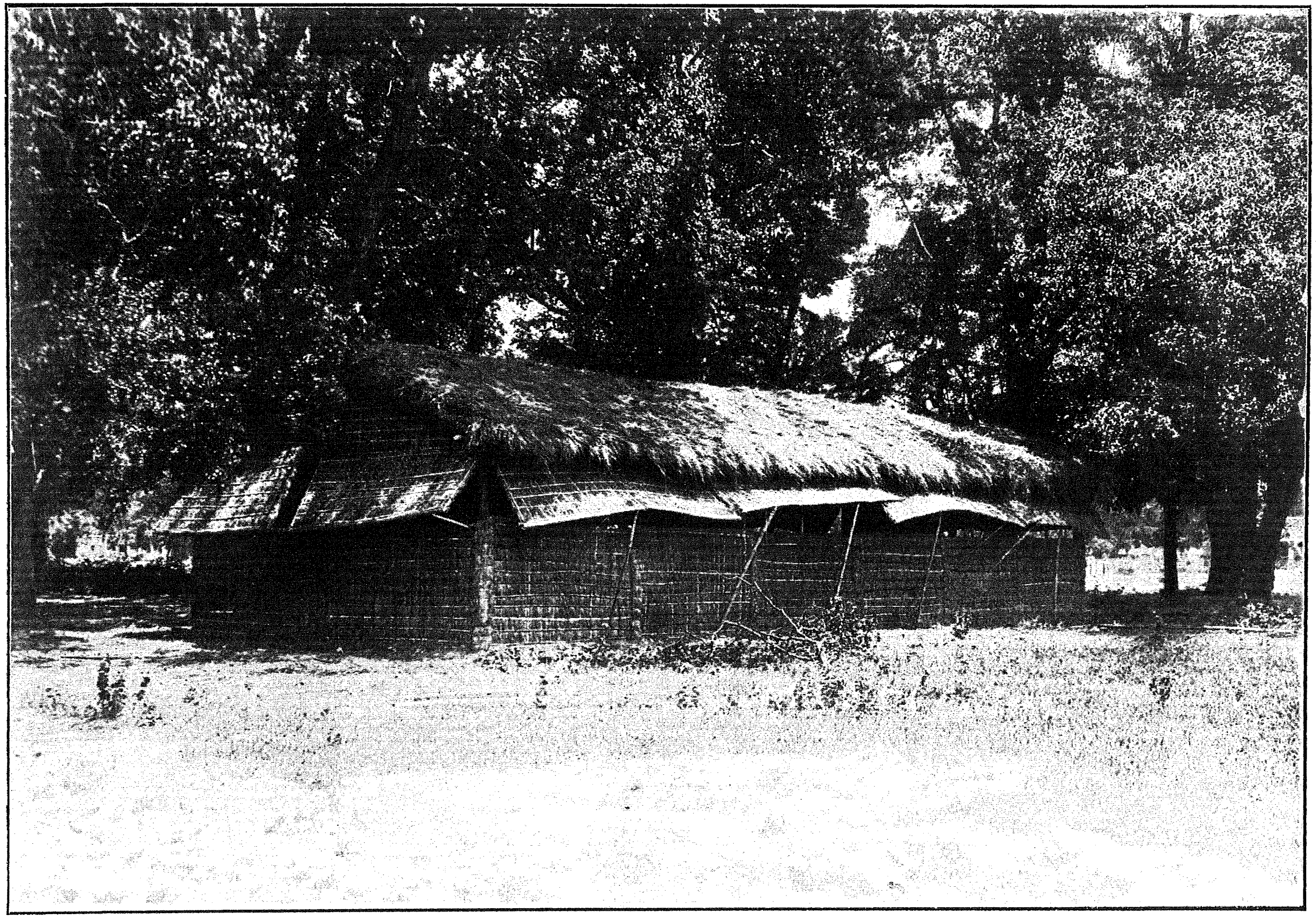
PLATE VII.



ERI SILK MOTH.

(Engraved and Printed by
THE CALCUTTA PHOTOT

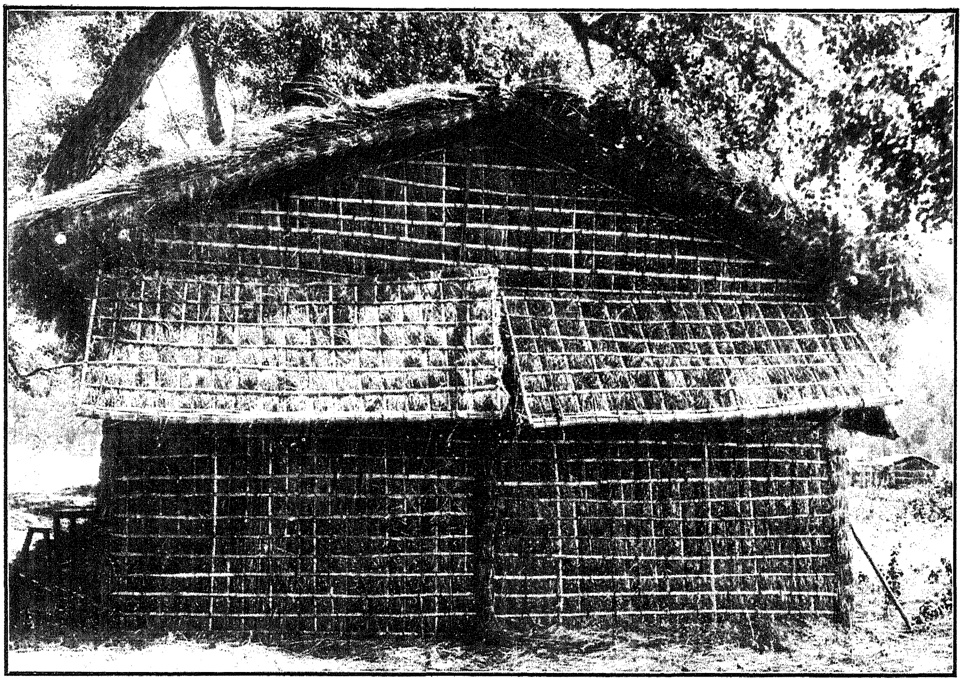
PLATE VIII.



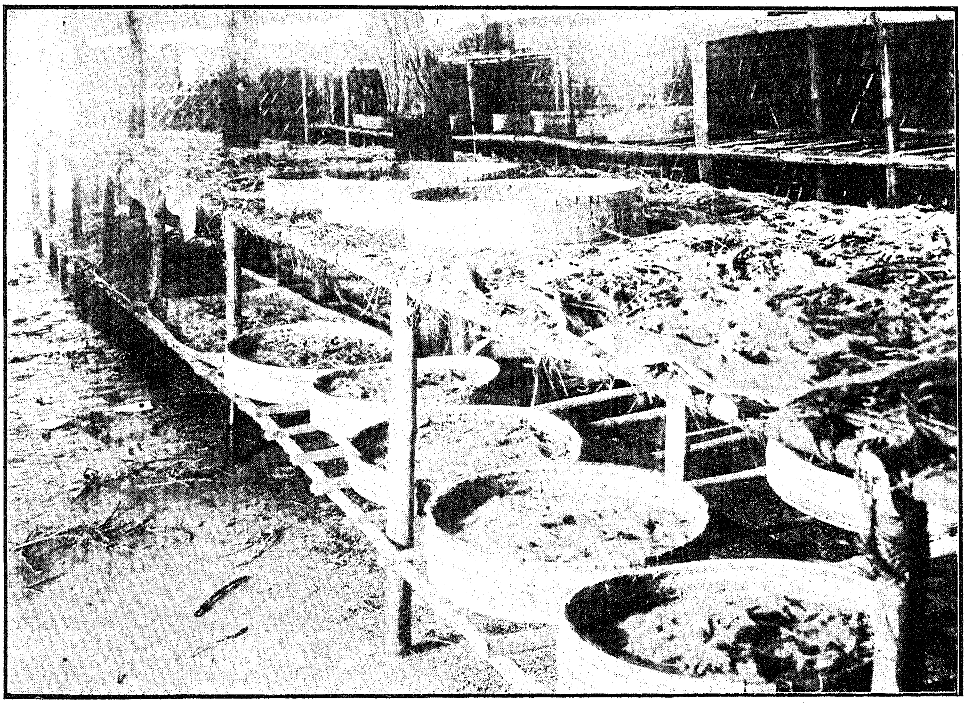
A. J. I.

REARING HOUSE.

PLATE IX.



End of Rearing House.



Interior of Rearing House.

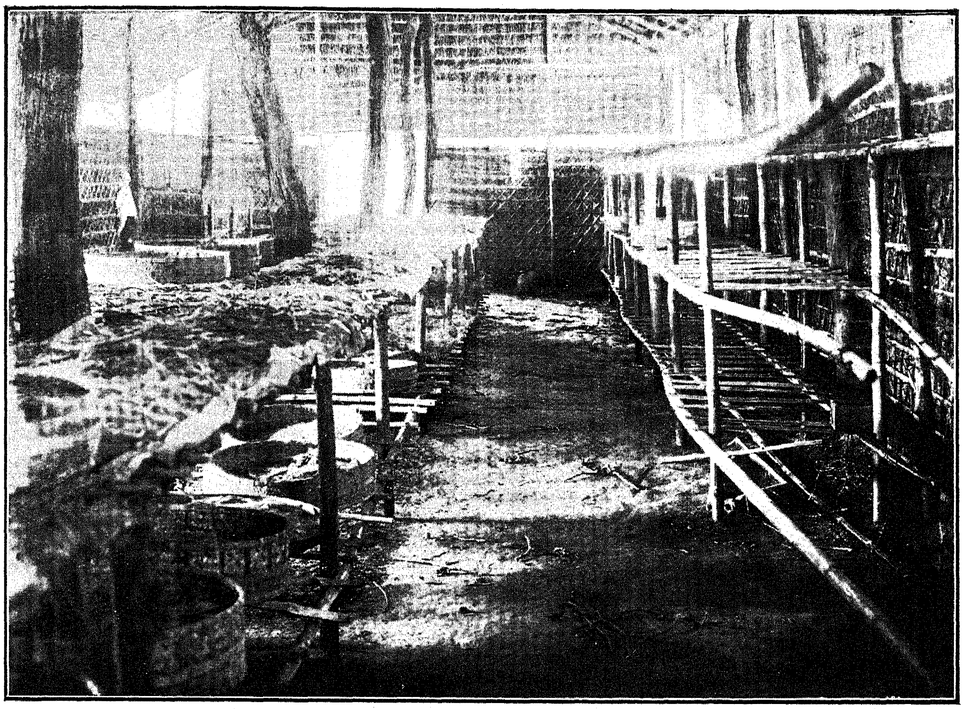
wherever the castor plant is grown. The eventual fabric thus produced is "Assam" silk, a very durable strong cloth, suited to the requirements of this country; but it must not be assumed that the finer silks of great delicacy and with beautiful gloss can be obtained. Fabrics more akin to cotton cloths are produced, but with the great durability characteristic of this silk, and by methods familiar in this country and requiring no appliances beyond those in ordinary use. It is impossible here to give detailed and complete directions for the cultivation of eri silk, but we deal with some of the more important points; anyone wishing to commence the cultivation can obtain eggs and fuller instructions from Pusa.

Rearing—The insect lives, as other insects do, in four stages; the moth lays eggs, which hatch to worms which feed on the leaf of the castor plant; the worms moult four times, at each moult increasing in size; when full grown (Plate VI), they retire into hiding and spin the cocoon; in this they change to the chrysalis, which lies motionless in the cocoon and requires no food; from this the moth emerges (Plate VII), which is of either sex; the sexes pair and the females lay eggs. The insects require attention in only two stages, the worm and the moth. The eggs are placed on a tray and left till they hatch. In dry weather they are covered with a damp cloth. When they are about to hatch, or when the first one is seen to hatch, they are covered with the youngest and smallest leaves of castor, spread out over them. They crawl up on the leaves and feed, and they can be removed attached to the fine leaves and put in a clean tray. As more hatch, the leaves are lifted and transferred. At first they are fed on the young leaves, washed free from dust if necessary. At intervals, moults occur, the worms ceasing to feed and throwing off their skin. This is a time when, if any are weak, they die. There are four moults before the last, the last occurring inside the cocoon. The full-grown worms, when ready to spin, become restless and move about; they are then placed in baskets filled with any convenient dry packing material, *e.g.*, the finely shredded wood used in packing delicate goods, wood-shavings,

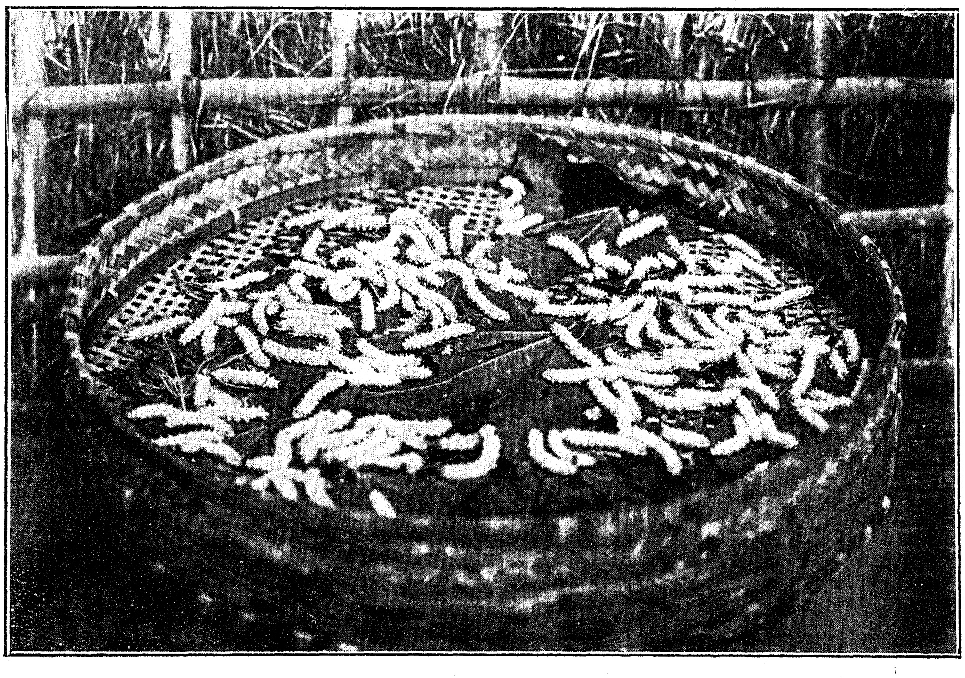
torn paper, dry straw or dry leaves (Plate XI). Into this they crawl and spin cocoons, first making a foundation, then spinning the regular cocoon inside. This occupies about three days ; the cocoons are left for at least a week and are then picked out by hand (Plate XII) and laid out before the moths emerge. The moths emerge with crumpled wings and gradually spread their wings ; they void a large drop of excrement, so it is advisable to let them crawl up off the cocoons (see special emergence tray, Plate XIII). The moths are then collected into baskets, where they couple. After twenty-four hours, the couples are separated, and the females put in other baskets to lay eggs, after which they die. The moths make no attempt to escape, and there is no need to confine them ; but coupling and egg-laying are facilitated by placing the moths in baskets, to which they can cling and in which the light is not too bright. The moths lay, as a rule, from 200 to 300 eggs each, and if a large brood is required, all the eggs obtained may be kept for hatching ; if not, only those from the best moths or only those laid on the first night (80).

In Pusa, seven broods are obtained during the year ; in hot weather about forty-five days is the total length required for the egg, worm, cocoon and moth stages. This increases to as much as eighty days in the cold weather of January and February, when the worms feed less rapidly, and the moths take longer to emerge from the cocoons. The worms are resistant to all weather but to a dry, parching heat ; in the hot weather when the west winds bring a temperature up to 110° F. with an extremely low humidity and an atmosphere laden with fine dust, the worms are less resistant to disease and may be unable to spin cocoons or to emerge as moths. At this time large numbers also fail to pass through the first moult. This is especially so if one has been rearing from too small an initial stock ; "in-breeding" is as bad in this species as in others, and if there is a period of dry, hot weather to be passed through, the stock should be as vigorous as possible. It is, therefore, advisable to be able to introduce fresh stock at intervals, as can be readily done by obtaining fresh seed.

PLATE X.

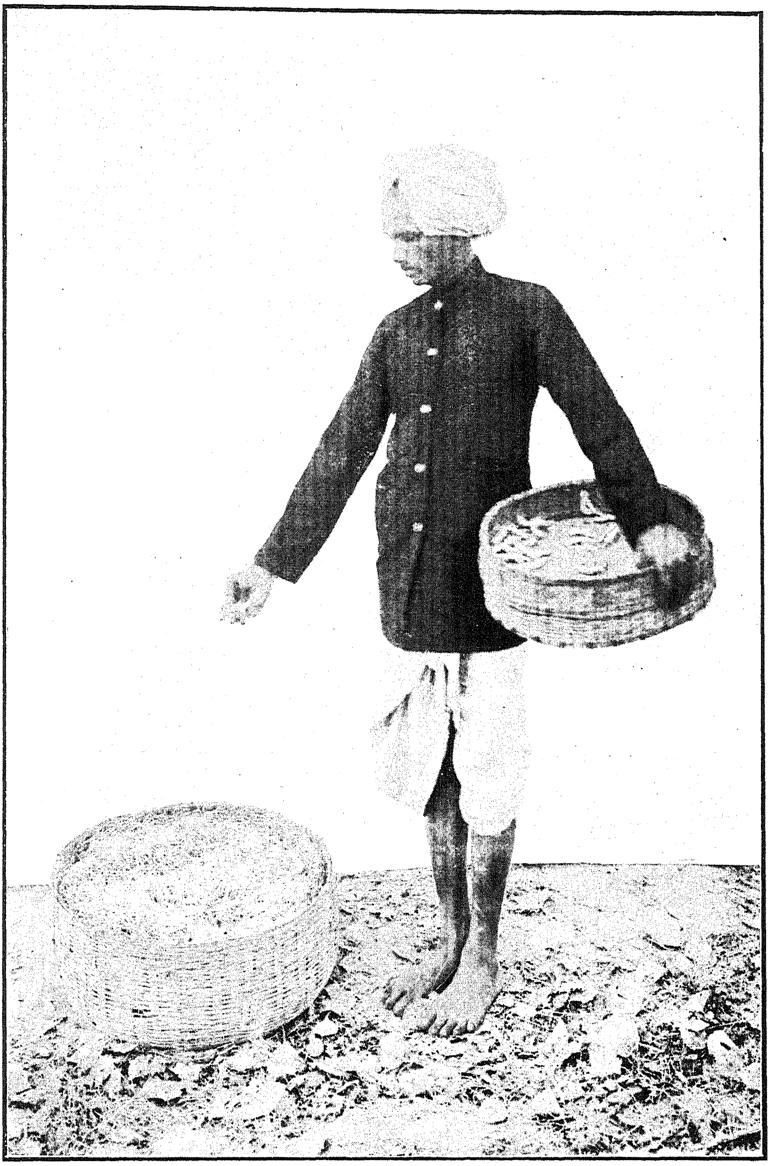


INTERIOR OF REARING HOUSE.



A. J. I. REARING TRAY.

PLATE XI.



A. J. I. PUTTING WORMS TO SPIN.

The insect at Pusa is not subject to any of the usual silkworm diseases, but has a peculiar disease, allied to flacherie, but with symptoms and characters which, in the opinion of the Imperial Mycologist, separate it clearly from that disease. The experience at Pusa has been that it is better not to rear it at all during the hot, dry months or, if that is desirable, to rear only from good stock. As a supply of seed from Assam is now readily procurable, there is no reason for attempting to rear during unfavourable seasons. In Assam a parasitic fly attacks the worms, but if only eggs are imported and not cocoons, this pest will not be found and does not occur generally in India. The insect grows most favourably in a moist climate, whether hot or not, and could be grown during the rains practically all over the plains. It is unsuited to the plains of Northern India during April, May and June. Starting on July 1st with 1,000 eggs, one would have 900 moths by August 15th, yielding about 80,000 eggs, which would give a very large brood ; the rate of increase is so large and rapid that one can easily start afresh every season.

Appliances—In rearing, very few appliances are required. The rearing-house may be any roofed structure of grass and bamboos, with earth-floor. A large supply of trays, made of split bamboo or similar material, are required, some with fine mesh, some with coarse, open mesh ; the former may be smaller. In these the rearing is done, and one may keep the largest worms also in large rectangular trays of any size up to four feet by three feet. For the cocoons and moths, baskets are required and a supply of paper, shredded wood, straw or other clean material for the worms to spin in. We have also used the special emergence trays shown in Plate XIII, but it is not essential. The trays are placed upon *machans* of split bamboo (Plates IX & X), which may be covered with matting. The legs of the *machan* should be smeared with some sticky material if ants are a trouble.

Food—The worms are wholly fed upon castor leaves, plucked as required, and the castor plants msut be available close at hand. For young worms, small leaves are used, but later the large coarse leaves are required. Varieties of castor have been

collected at Pusa from all parts of India; some are better leaf-yielders than others, but all are eaten, the bronze or red ornamental variety grown in gardens being, however, disliked. The varieties in cultivation are apparently all suitable, some yielding more leaf than others. We are not here discussing the question of growing the worm on a large scale for factories, but rather of utilising available castor leaves, at present of little value, for producing silk. The best varieties for growing specially for silk and the best systems of plucking, etc., are under investigation at present. So far as can be seen at present, an acre of castor, not too heavily picked, should yield fifty to seventy-five maunds of leaf as well as a yearly normal crop of seeds. When castor is not available, the leaves of Ber (*Zizyphus jujuba*) can be used, and in Assam the leaves of Papaw (*Carica papaya*), Gulasiphol (*Plumeria alba*), Cassava and some trees are used, but not for rearing on any scale, only to keep a few worms alive from season to season.

Utilisation of the Silk—The cocoons, after the moth has emerged, are collected; they sell at present for about Rs. 70 per maund in Calcutta, but can be more profitably grown for local use. Of good cocoons, 2,500 go to a seer; of small ones, as many as 4,000. It requires 75 lbs. of castor leaf to feed the number of worms, large or small, which produce a lb. of cocoons. A seer of cocoons, after treatment, yields about twelve chittacks of thread (75%). The cocoons are, in Assam, both brown and white; in Pusa, by rearing from white cocoons, or from some other cause, only white cocoons are obtained; the colour is immaterial as, in the boiling off, the brown of the cocoons is dissolved off. The cocoons are boiled in water containing either castor ash or soda. Castor ash, *i.e.*, the ashes of castor stems and branches, contains about 28% of Potassium carbonate; on boiling the cocoons in water containing a seer of ash to each seer of silk, with enough water to cover the cocoons, the gum on the thread is dissolved and the cocoon becomes soft. In using soda, one takes for each seer of silk a quarter of a seer of soda and boils for three-quarters of an hour, and this is the best treatment.

PLATE XII.

A. J. I.

PICKING OUT THE COCOONS.

The cocoons are then washed and are ready for spinning. Spinning may be done on the usual spinning wheel (*Charka*) used for cotton, from either the wet cocoon or from the dry one, or on the Taku, used in Assam for this silk (Plate XIII). One method is simply to spin from the wet cocoons, the spinner taking a lump of them in one hand. Another is to dry the boiled cocoons, and to card out the silk into a mass like cotton or wool, loose, dry fibres, and spin from that. The former gives a finer, closer thread of dirty colour, the latter a white, fluffy thread less suited to fine weaving. The latter thread is readily made by those who understand wool-spinning, as in the Punjab. An improvement in spinning has been effected by the use of a new machine, in which the spinning is continuous by means of the "flying needle" and is done on to bobbins direct. This machine has been worked out at Pusa and is in use there. It facilitates the spinning of coarse thread suited to the requirements of the country, and is a simple machine easily made and worked.

The thread produced is woven in the usual way and is suited to the handlooms of this country. A variety of looms are being employed, but we have nothing original to offer on this subject, and the usual method of weaving may be adopted. In this way, by using either the ordinary spinning methods used for cotton, or by using the new machine, and by utilising the ordinary weaving of the district, one can produce good durable cloth, of a white or écru colour, either fine or thick, with great durability and wearing qualities. The silk has not the appearance of the fine reeled silks; it has not the gloss and the sheen, but is best described as being the familiar Assam silk.

The dyeing of this silk is easy; the indigenous dyes of plant origin are especially suited to it; alizarine or anthracene dyes give brilliant and fast colours; aniline dyes give a large range of brilliant colours; some fairly fast, some fugitive. The cocoons may be dyed or the cloth, and a great variety of colours, fast to light, can be produced. Careful tests have been made of a great variety of dyes and, while the ordinary methods of using indigenous plant dyes for silk are applicable to this silk, we would

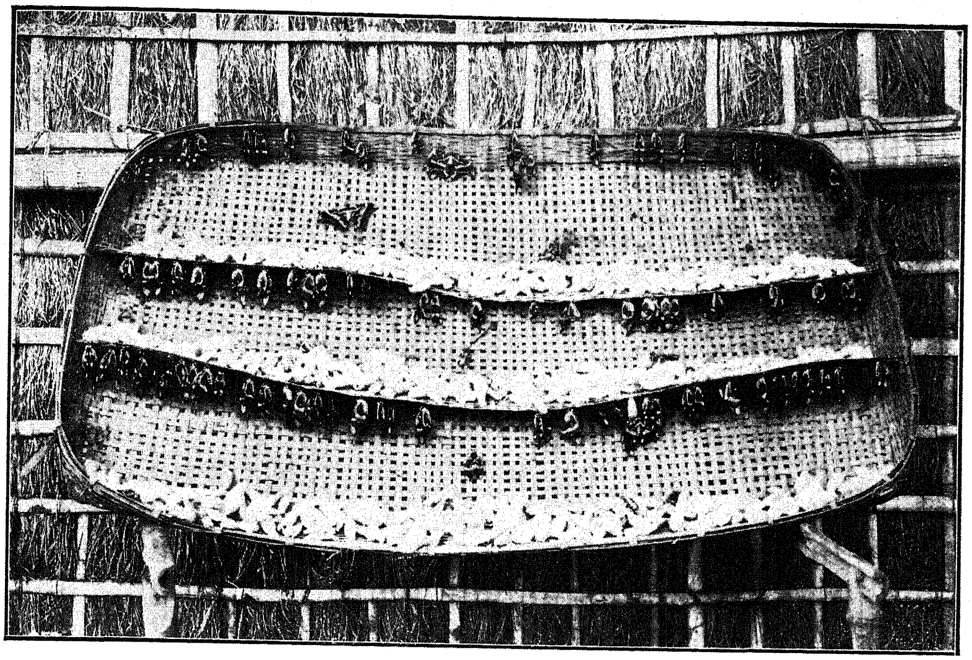
urge the use only of fast dyes, whether indigenous or not. It is impossible here to enter further into this question, but there are no special difficulties in dyeing, and full information can be obtained from Pusa. Good fast colours are obtained with indigo, lac-dye, backam, palas, manjista and jackwood, among indigenous colours; with the alizarine (mordanted) dyes and with some aniline (acid, direct or developed) colours. The reader may consult Bannerjee's *Dyeing in Bengal* or E. R. Watson's *Fastness of the Indigenous Dyes of Bengal* (*Memoirs*, Asiatic Society of Bengal, Vol. II, No. 7, p. 155).

Eri as an Industry—At the present time, eri silk is grown in Assam partly to supply clothes to the grower, partly to satisfy a demand for Assam silk cloth, produced at factories in Gauhati and elsewhere. We believe there is a large field for its extension, as a minor or home industry, wherever castor grows in India; the seed is obtainable and is readily sent by post to all parts of India; the rearing is simple and can be done on a small or large scale once it has been seen; the production of thread and cloth offers no difficulties to people accustomed to spinning and weaving cotton; and there is no inherent difficulty which would prevent its adoption in all parts of India where castor is grown and where the climate is suitable. The culture of the worm on a large scale, or its utilisation on a large scale in power looms, is a matter of commercial enterprise and not our immediate concern. Where castor is available, large quantities could be produced and either spun or woven locally, or collected and utilised in a factory.

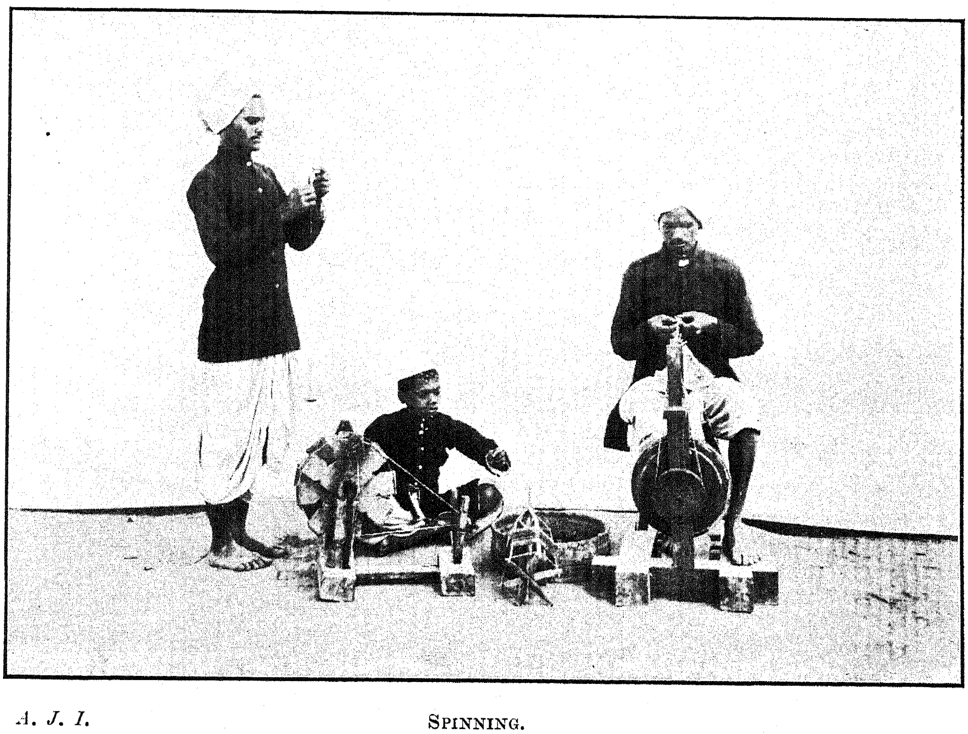
In Behar, the cost of producing the cocoons, spinning the thread, and weaving the cloth, totals up to much less than the market value of the cloth, though full wages are paid to the rearers and spinners; where the rearing and spinning are done by whole families including women and children in their leisure time when fieldwork is not pressing, it represents a valuable minor industry.

At the present time, the seed is obtainable only from Assam or from Pusa. We would emphasise the very grave danger of obtaining live cocoons from Assam, since they carry the parasitic

PLATE XIII.



MOTHS EMERGING.



A. J. I. SPINNING.

On the left the Taku, the Charka in the middle, and the Pusa Continuous Spinning Frame on the right.

fly, the most dangerous enemy to the worms; and, as a rule, seed obtained in the ordinary way from Assam is bad. Good seed will be sent from Pusa, and, if notice is given, a large supply of seed is usually available. A limited number of men, trained to the work, are available for starting the industry in new places, and anyone wishing to learn it can be taught in the Pusa rearing house in a short time. The industry is being taken up in different parts of India, and wherever there is a demand for light remunerative work, such as can be done by women and children, if castor is available, the rearing, spinning and weaving of this silk offer many advantages.

THE MANAGEMENT OF EXPERIMENT STATIONS IN INDIA.*

I.

By W. H. MORELAND, C.I.E., I.C.S.,

Director of Agriculture, United Provinces of Agra and Oudh.

ALL administrative officers will sympathise with Mr. Standen's desire that Experiment Stations should be worked as economically as possible, and that their arrangements should not be such as to give an impression of lavish expenditure. I fear, however, that the remedy he proposes—the striking of a balance-sheet for non-experimental operations—involves considerable risks. For one thing, there is the danger that officers outside the department may attach undue weight to the balance-sheet, and that when provincial resources are depleted, the department may be called on to improve its contributions under penalty of a reduction in its grants. This is not a fanciful danger: a leading agriculturist in Australia told me some years ago that the whole department in one Australian State was crippled by the obligation to show a profit on its farming operations; and though an Indian Provincial Government is not likely to put the matter so crudely, Resolutions and Reviews, which should pass lightly over the experiments, but comment favourably or unfavourably on the financial results, might have a most insidious effect on the managing staff.

Even if the balance-sheet were treated as a departmental secret, I fear it would still have an injurious effect: the

* In Vol. III, No. IV of this Journal, Mr. Standen wrote an article on the above subject and we, in a note, invited criticisms on it. The present articles are written in response to that.—EDITOR.

subordinate staff of an experiment station must give its attention first to the experiments, and it would be trying the staff rather highly to require them to show a profit at the same time. There would be the temptation to scamp a laborious piece of experimental work in order to get the profit-making crops into the ground, or to harvest perishable crops quickly, or to perform any of the numerous agricultural operations where the right time is everything; and even if the temptation were resisted, there would still be an undesirable diversion of interest from the main object of the station.

Again, the distribution of the expenditure would, as Mr. Standen recognises, have to be largely arbitrary, and there would be a wide scope for that unprofitable hair-splitting in which many Indians (and Englishmen too for that matter) are so fond of indulging, the general aim being to throw all possible items into the experimental account. This would involve, I fear, a considerable amount of time spent in book-keeping by the responsible officer in charge, who could usually employ his time more profitably.

Lastly, I cannot share the hope implied by Mr. Standen, that the accounts of the non-experimental work of an experiment station can demonstrate that high farming on a capitalist basis is a paying enterprise. It would be straying too far from the question under discussion to consider the best form of such demonstrations: in some parts of India at least, they must be preceded by experiments to decide whether or not such farming can be profitably carried on: but my present point is that the limitations of an experiment station are all against a real demonstration of profitable high farming. Such a station will ordinarily include (*a*) a small area under experiment; (*b*) a larger area awaiting new experiments; and (*c*) an area (which will, for some time, increase in size) recovering from closed experiments. Now, the treatment of the land awaiting experiments is a matter of the utmost importance: the object should be to have as many blocks as possible of *approximately uniform productivity*; and this involves the

determination of yield in very small sections (a most expensive operation); and also I think a very sparing use of manure except on the land that is not uniform at the start. And the treatment of land after experiment must, in the same way, be adapted primarily to make it fit for fresh experiments (a tedious matter where the manurial treatment has been differential). It seems to me that these conditions of work are not compatible with a demonstration of profitable high farming.

In practice, then, we must, I fear, be content with an approximation to Mr. Standen's ideal. For one thing, areas occupied by demonstrations should be clearly separated from experiments, as was recognised by the Board of Agriculture in 1906; and ordinary cultivators should not be encouraged to visit the experimental area. But as unskilled visitors cannot altogether be excluded, I suggest that some restraint should be exercised in laying out experiment stations, and that proposals for heavy initial expenditure should be considered not from the point of view of convenience or appearance, but from that of indispensability for experimental work. It will probably be found that buildings erected in country fashion by the staff will serve most purposes: that the manure can be effectively conserved by methods within the reach of cultivators: and that most of the tillage can be done by the cattle of the locality.

II.

By C. BENSON, M.R.A.C.,

Late Deputy Director of Agriculture, Madras.

In the October number of the *Agricultural Journal of India* you invite criticisms of Mr. Standen's article on the "Management of Experiment Stations," and though I am no longer concerned in the matter, I still venture a few remarks thereon.

Mr. Standen starts by defining the object of such stations as being to 'solve certain problems of sufficient importance to warrant the expenditure of public money,' and then proceeds to

describe how at 'many, perhaps the majority, of the experiment stations in India' the area taken up is far larger than is needed for the conduct of the experiments designed, and how such a station is, in fact, a highly cultivated farm, equipped and staffed on an expensive scale; and he then urges that 'there is a danger that the perfection of the buildings, stock, etc., may diminish the practical value of the experimental work' thereon. He, therefore, puts forward the proposition that 'in designing an experiment station, it should be borne in mind that, after making allowance for the staff and buildings required for the experimental part of the area, the value of the produce of such parts of the farm as are not used for experiment should be sufficient to cover the cost of management and cultivation, including interest and depreciation on cost of buildings and to yield a substantial profit besides.' At the close of his article, however, Mr. Standen adds a rider which shows that he recognises that the management of such stations must not be to risk their main objects in the pursuit of 'profit-making.' This is, however, rather by the way of 'hedging' on the main contention.

It may be admitted that, if it is unavoidable in designing an experimental station, areas so large as Mr. Standen mentions should be taken in, some plan must be evolved for combining 'profit-making' or commercial farming with experimental farming, even though no one would be convinced by results achieved by book-keeping, whilst the people of Southern India say that 'keeping accounts is possible in trade, but not in agriculture.' It must also be admitted that commercial undertakings in almost all cases, and commercial farming in particular, cannot be undertaken satisfactorily by the State, or at least, if undertaken by the State, must prove far less remunerative than when in the hands of private individuals. In the case of a farm conducted for 'profit-making,' the commercial result depends most frequently on the business aptitude of the manager, as a buyer and seller; that is, as a trade, and not on his skill as a cultivator. And as a trader on behalf of the State, the manager of an experiment station is handicapped, and handicapped heavily, if

not fatally, in all his operations which are, moreover, limited and circumscribed by the methods of the account department.

But the idea that a State farm should be managed with a view to profit-making, seems to me a mistake. I once held ideas somewhat similar to those set out by Mr. Standen, but experience taught me otherwise, and I believe that endeavours to pursue that course would end in a great waste of time and public money, and set back the really valuable work of the experiment stations. Although, 'cultivation is like a stone in a madman's hand' in respect of the results that the cultivator may achieve, and one cannot, of course, go so far as to say, as is said in Madras—

If the ploughman count the cost,
Even his ploughshare will be lost,

in the case of some State-managed farms a profit may be fairly worked out by its books; such a case will always be exceptional and will occur where a farm is devoted not to general or typical farming, but to the cultivation of some one or two very valuable staples. On the other hand, there are some staples demanding attention and work on, perhaps, a farm of the size Mr. Standen mentions from which at present it would be hopeless to expect commercial returns on a State-managed farm, and the pursuit of 'profits' would probably wreck the whole work. I say this because, if profit-making were to be considered at all, official and public attention and criticism would in almost all cases be centred on the immediate 'financial' results, and the farm managers would be led to concentrating their attention and energies on this aspect to the detriment of the infinitely more important object or objects for which the farm was established; and this too in pursuit of a chimera, if for no other reason because on a public farm there must be a regard for appearances and a lot of 'eyewash' is required to meet uninstructed criticism, and this costs money, whilst on such a farm the manager cannot leave undone or postpone to the most convenient season the thousand and one things that the ryot or private individual would.

But, be opinion on these points what it may, Mr. Standen's article appears to me to be a most damaging criticism of the

manner in which 'many, perhaps the majority, of the experiment stations in India' have been started, in that he shows most conclusively that for their objective 150—200 acres is a far larger area than is required. In so far as this presentation of the facts is accurate, I believe that he is quite correct, and that such farms, in general, are a mistake and a most expensive one. There are, no doubt, circumstances which justify the taking up of so large an area with a view to the production of good seed, but that is another matter from experimental farming, and there seems to me to be no necessity for making experiment stations more than, in general, 40—50 acres in extent, though the area must vary with local conditions, and in some cases they might be much smaller. Such areas* would provide for the experiments designed at the starting of the station and for their almost inevitable expansion as time goes on. Although India is a country of small and of very small holdings, it must be remembered that the ryot in his cultivation does a great deal of co-operative labour, and thus the economic difficulty of working such small areas as he usually deals with is got over, but this kind of work is not possible for an experiment station, and it is necessary that its area should be such as would allow of a minimum of two pairs of cattle performing all the work thereon. More than this would entail unnecessary expenditure, both of capital and in recurring charges.

Should experiment show that it is advisable to extend operations so as to admit of producing high class seed, it is possible that the commercial idea might be allowed to prevail, but then would arise the very difficult question of determining the value to be put on such produce before the accounts are made up, for it is questionable whether the ordinary cultivator has as yet conceived the real value of such supplies, or would give them for State-grown produce.

It should also, I think, be recognised that an experimental station should not be looked upon as a place to which the uninitiated should be asked to resort in order to see the wonder-

* It must be remembered that no inconsiderable area will go out for roads, buildings, etc., and that the experimental area must be select ; thus only odd corners will be left.

ful things that the 'Sirkar' is accomplishing—that would connote the ancient and exploded idea of 'Model' farming—but should be devoted to experiment only. And it is here that Mr. Standen seems to show a confusion of ideas; for experiment is one thing and demonstration is another altogether, and it appears to me essential, if good results are to be expected, to keep the two separate and apart.

In the matter of demonstration, it also appears to be essential that the fact that what is possible and possibly advisable on a farm of 150—200 acres is often neither possible nor advisable on the minute holdings typical of the country at large. I would also suggest that there should be no greater difficulty in demonstrating the effect of the more thorough application of practices now in common use, than in demonstrating new methods—both may be matters of considerable difficulty and either may be very easy.

At first sight, then, there appears to be much to commend itself in Mr. Standen's contention as to the advisability of considering in the case of experiment stations in India the commercial side of their farming operations, but, if more deeply considered, it will, I believe, be found that it is based on a confusion of ideas and an assumption which is not tenable; whilst, if the assumption were admitted to be acceptable, I doubt, first, whether the idea he contends for is feasible, and, secondly, even if it is feasible, whether by any mere book-keeping the object he holds in view would be attained.

HINKIPU, HEAVITREE, EXETER,
26th Jan., 1909.

III.

BY H. C. SAMPSON, B.SC.,

Deputy Director of Agriculture, Madras.

REFERRING to Mr. Standen's article on the 'Management of Experiment Stations' in the October number of the Journal,

the writer is evidently exercised in his mind—and in my opinion rightly so—on the different conditions under which an Agricultural Station, such as he describes, is worked from those under which the ordinary cultivator has to work. Certain conditions must be different. A cultivator's time is his own, and his wages are the crops which he reaps, but on an Agricultural Station much of the labour has to be hired and paid for, no matter what the weather or work to be done is. The ryots' cattle are his own, and he can hire them out or use them for carting on the roads when they are not wanted on the land, and can thus often pay for their keep ; but on an Agricultural Station the bullocks can only be used for the work connected with it. Thus the cost of cultivation of a crop on an Agricultural Station may in accounts show a loss, while under similar treatment in a ryot's hands there might be a considerable profit. Cattle-sheds, again, are in many districts quite a new idea. In some places, the animals are treated as members of the family, or in other places, are tied on the verandahs, but such buildings, even though they are designed and constructed as simply as possible, are essential on an Agricultural Station. The seed-store is another building which is essential, and it is also essential that this should be dry and well ventilated, especially if the Agricultural Station undertakes the sale of seeds, but with these exceptions the conditions should, as far as possible, be the same as those under which the ryot works. As the writer of the article implies, the Agricultural Department is meant for the benefit of the cultivator, and one is, perhaps, too apt to forget what the cultivator is. In the majority of cases, he is illiterate. He is bound to the customs, superstitions and traditions of his own village. If you ask him whether he has ever tried this or that practice, he may say that they do it in the next village, but it is never done in his own. Yet it is possible, if such a man visited an Agricultural Station and was not distracted or bewildered by the lavish expenditure on buildings, machines and cattle, and if he were to see the two crops growing side by side under similar conditions that he might change his method if he saw that it was to his advantage. There

are experiments which a cultivator can understand and can learn from an Agricultural Station, and until he has been educated up to even this point, the experiments should be confined to such and similar experiments which the Deputy Director should be able to devise with his knowledge of the whole Division, his scientific training and the assistance which he should be able to obtain from the results of the research side of the Agricultural College and Central Experimental Station. Afterwards when the ryots' confidence has been won, other experiments dealing with slightly more complicated problems could be introduced, but they should always be such that the object of these can be intelligently explained to the cultivator. The man whom the cultivator would ask about the experiment would not be the Deputy Director of Agriculture, nor would it often be the Manager, but usually it would be the cooly who works on the farm. If this man cannot explain, how is it expected that the casual visitor will understand? It stands to reason that the farm cooly should be the exponent of the experiments to cultivators. He is one of themselves, he knows their difficulties as his own. He is not newly imported into the district, and he can make a very shrewd guess as to which method or experiment is likely to be most profitable. Then, again, when a thing has been proved by experiment, it is most essential that it should be demonstrated and again compared on a larger scale, and such demonstration should, in my opinion, be always done on the Agricultural Station where the experiment was originally carried out, even though other demonstrations may be conducted in other parts of the district. For this reason alone, it would not be possible to work the 'non-experimental' area solely for a profit.

The writer of this article gives one the idea that in starting an Experimental Station it is possible to fix definitely the lines of experiments which are to be conducted, and that when these are once started, the only thing is to work out and tabulate the results. If this is his idea, I cannot agree with him. The more one studies the crop on the farm and tours in the tract that the Station is meant to represent, the more one feels how only the

fringe of the question has been touched upon. Under these circumstances, it seems to me that the experimental area must change. Fresh experiments must be taken up, and old ones which are never likely to give any practical results must be given up.

If an Agricultural Station is to be run on the above lines or any lines, I do not see how any adjustment of accounts will ever do any good. If the cultivator cannot understand the object of expenditure on buildings, implements and cattle, how is he to be expected to understand account adjustments? If you can say to him that this plot or field under this treatment gave a crop worth so much, and the net profit after paying for all the cultivation, seed, manure, harvesting and threshing was so much, he can understand that, and the system of keeping cultivation sheets as adopted on the Agricultural Stations in the Madras Presidency seems to fulfil all requirements. These cultivation sheets are kept for every field and plot, whether experimental or not, as long as they are under cultivation. They are posted up periodically like a ledger, the cash book being the Daily Record sheet which shows all cooly and cattle labour and all money transactions for each day. Specimens of these are enclosed.

Many may say that there are problems which require solving which would be wholly unintelligible to the cultivator. Granted that this is so, but is an Agricultural Station which is in charge of a Manager and which is only periodically visited by the Deputy Director, the best place to do this? Surely, in the present state of agricultural advancement such intricate problems should be done on the Central Agricultural Station attached to the Agricultural College. The site of this, one may take it, has been carefully chosen so as to represent as many local conditions as possible. Every experiment is under the direct charge of the Superintendent who is himself a trained officer, and there is every facility for the co-operation of the expert officers of other branches of science who are also stationed there.

DAILY RECORD SHEET.

DAILY RECORD OF THE KOILPATTI AGRICULTURAL STATION.

Field or Head.	Nature of Work.	Area. Cents.	Labour. Permanent coolies. As. 4½	As. 4	As. 3½	Casual coolies. As. 3½	As. 3	As. 2½	As. 2	Pair of cattle.
Yard	Attending to cattle, cattle-hed, &c.	...	...	...	...	..	1	½	...	...
Maintenance of cattle	Cutting grass for cattle ..	...	...	...	...	...	...	...	10	...
3. Raggi	Irrigating ridge portion whole water used 1,012½ c. ft.	·35	...	...	⅝	...	...	...	⅝	⅝
	Irrigating beds, a portion only, water used 900 c. ft.	·18	...	...	⅜	...	...	...	⅜	⅜
4. Cowpea varieties	Collecting pods	...	...	...	...	...	...	...	1	...
4. Do. do. ...	Handpicking bags	...	1	...	...	...	...	...	1½	...
5B. Raggi	Irrigating (irregular portion)...	...	...	...	...	1	...	...	1	1
9B. Sweet potatoes...	Clearing water channels preparatory to irrigation.	...	...	...	...	...	...	½	...	...
22. Cotton ...	Weeding and thinning ...	2·00	...	...	...	...	...	...	11½	...
22. Do.	Dibbling seed in blanks ...	2·00	...	...	...	...	1	1	1½	...
22. Do.	Working bullock hoes ...	1·50	...	¼	...	½	...	...	...	¼
24. Do.	Do. do. ...	...	...	¾	...	1½	...	...	...	¾
Miscellaneous cultivation expenses.	Head cooly supervising work...	...	1	..	...	...	...	...	...	...
Maintenance of cattle	Grazing cattle	...	...	...	...	...	...	...	1	...
	TOTAL ...	...	2	1	1	3	2	2	28½	3

DATE 18-11-08.

MANAGER'S DAILY NOTES.

Charges.

	Rs.	A.	P.
Freight on parcel of maize seed from Nellikuppam	1	0	0
Wages to coolies for the week (12th to 18th) ...	45	8	3
Advance to coolie, Vellayan	1	0	0

Charges under improvement of cotton cultivation grant.

	Rs.	A.	P.
Wages ...	15	3	6

Assistant Manager, Venkaswami Rao, left this station on tour to Perambalur.

(Sd.) A. V. THIRUMURUGANATHAM,

Manager.

CULTIVATION SHEET.

KOILPATTI AGRICULTURAL STATION. CROP—UPPAM COTTON, 1907-1908.

No. of plot or plot subdivision.	Area of Plot.		Yield of Crop.			Value of Produce.		Cost of Production.		
	Acre.	Cent.	—	Per plot.	Per acre.	Per plot.	Per acre.	—	Per plot.	Per acre.
				LB.	LB.	Rs. A. P.	Rs A. P.		Rs. A. P.	Rs. A. P.
Field 21 ...	8	20	Produce Kappas ...	5,220½	636½	424 7 8	51 12 3	Preparatory Cultivation	44 4 6	5 6 5
								Manure	26 5 8	3 3 5
								Seed	3 0 0	0 5 10
								After Cultivation ...	35 4 0	4 4 9
								Irrigation	.....	......
								Harvesting, Threshing...	63 14 11	7 12 9
								Total ...	172 13 1	......

CROP—UPPAM COTTON. KOILPATTI AGRICULTURAL STATION, 1907-1908.

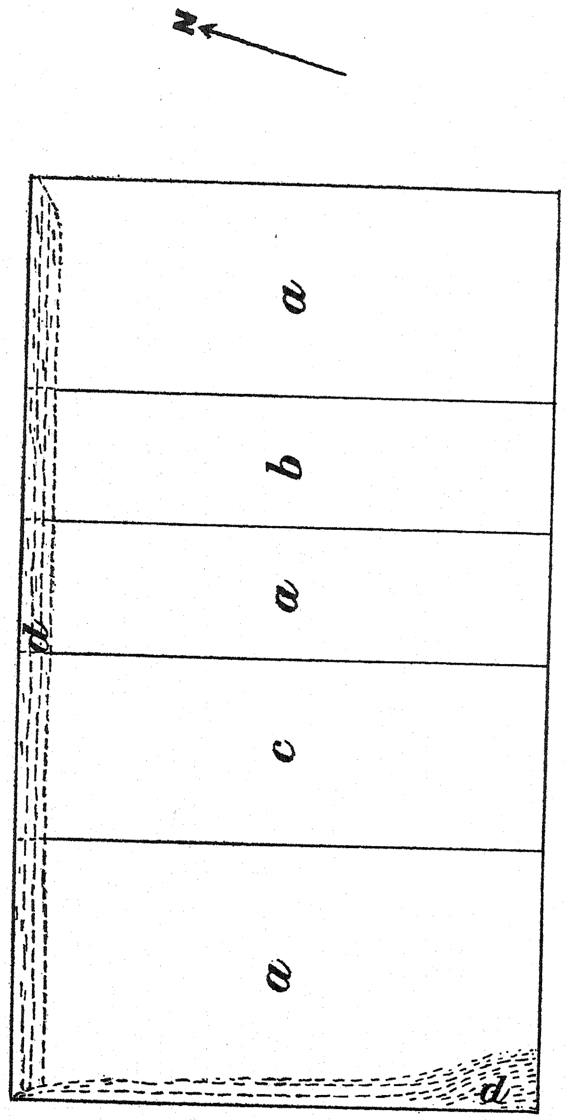
Date.	Description of work.	Men.	Women.	Boys.	Bullocks.	Cost of work. Rs.	A.	P.
20-2-07	Working blade cultivator after harvest, 5 acs. ...	2	...	...	2	1	8	0
21-2-07	Do. do. 1·60 acs. ..	2	...	...	2			
21-2-07	Do. do. across 3·50 ,, ...	2	...	...	2	1	8	0
26-2-07	Do. do. do. 4·40 ,, ...	1	...	...	1	0	12	0
19-3-07	Do. do. do. 3 ,, ...	1	...	...	1	0	12	0
27—31-5-07 & 1—4-6-07	Working cotton soil plough whole area ...	34	...	...	34	25	8	0
29—31-5-07 1—3-6-07 & 15—17-6-07	Sheepfolding (6,918 sheep)	...	...	...	...	20	11	8
Same dates	Guarding and watching sheep	24	...	...	...	5	10	0
8—10-6-07 & 18—20-6-07	Ploughing the whole area to cover sheep dung, etc.	11¼	...	...	11¼	8	7	0
22-6-07	Working blade cultivator over whole area ...	2¼	...	...	2¼	11	11	0
6-10-07	Removing rank weeds preparatory to sowing ...	...	4½	...	...	0	9	0
17-10-07	Sowing cotton (80 lbs. seed) with drill covering with blade cultivator	6	...	...	4	3	7	6
17-10-07	Removing rank weeds preparatory to sowing ...	...	1	...	...	0	2	0
19, 22 & 23-11-07	Filling up blanks with seed	5	7	...	...	2	0	9
24-11-07	Thinning plants	1½	...	...	...	0	5	8
23, 26 & 28-11-07	Weeding and collecting weeds	2	19	...	...	2	13	6
22-11-07	Working blade cultivator to remove plants into the area to be resown, 1·10 acres	½	...	...	½	0	6	0
23-11-07	Resowing and covering, 1·10 acres	1¼	...	...	¾	0	10	11
3, 4-12-07	Second thinning	¾	12	...	...	1	10	9
3-12-07	Hand weeding in the rows (contract) whole area...	¾	40	...	...	5	0	0
3, 4-12-07	Working bullock hoes	5	...	...	2⅓	1	15	6
22-12-07	Ditto 3 acres	1½	...	...	½	0	9	9
23-12-07	Ditto rest of area	3	...	...	1	1	3	6
27-12-07	Ditto (resown portion 1·10 acres)	½	...	...	⅙	0	3	3
27-12-07	Thinning ditto	...	2	...	...	0	4	0
4, 5-1-08	Weeding in the rows	½	6	...	...	0	13	11
5-1-08	Second thinning (resown portion) 1·10 acres ...	½	2	...	...	0	5	11
7, 8-1-08	Weeding in the rows, 5½ acres	1	24½	...	...	3	4	9
9, 10-1-08	Working bullock hoes	4½	...	...	1½	1	13	3
22, 23-1-08	Ditto	5¼	...	...	1¾	2	1	2
3-2-08	Thinning resown portion 18″ apart as per Deputy Director's order	1	5	...	...	0	13	9
22-2-08	Working bullock hoe, 1·10 acres	½	...	...	⅛	0	3	3
2-3-08	Picking stray kappas	...	1	...	...	0	2	0
8, 10, 12-3-08	Removing hariali grass in patches	1	27	...	...	3	9	7
11-3-08	Working bullock hoe, 1·10 acres	¾	...	...	¼	0	4	9
12, 13, 17, 18, 21, 23, 25, 26, 28, 29, 31-3-08	Picking kappas	3	94	...	...	12	7	4
1, 6, 7, 8, 9, 10, 11, 16, 17, 18, 21, 22, 23, 24, 25, 26-4-08	Ditto	17	253¾	...	...	35	11	3
	Total ...	...	...	...	...	149	8	8

CROP—UPPAM COTTON. KOILPATTI AGRICULTURAL STATION, 1907-1908—*concld.*

Date.	Description of work.	Men.	Women.	Boys.	Bullocks.	Cost of work. Rs. A. P.
27-4-08	Working bullock hoe, 8·20 acres...	6	...	...	2	2 7 0
2, 3, 15, 28-5-08; 13, 14, 22, 23, 28-6-08; 1, 4, 5, 10, 11, 19-7-08	Picking kappas	½	74¼	...	...	9 6 4
19, 20-5-08	Working bullock hoe	5⅕	...	...	11⅕	2 3 1
	Pulling out cotton plants and stacking the same on the field (8·20 acres) piece work	...	...	...	...	6 4 0
	TOTAL ...	...	...	...	...	169 13 1

Date.	Descriptive notes on the crop.	
	Date of sowing ...	17th October 1907 (1·10 acres resown 23rd November 1907).
	Date of flowering ...	Commenced about 20th January 1908.
	Date of harvesting ...	Picking kappas commenced 2nd March 1908. Season picking over by end of April. Summer picking from 13th June 1908 to 19th July 1908.
22-10-07	Germination good and uniform.	
30-10-07	A kind of grey weevil which has become a pest this year has caused many blanks, eating away the young shoots which have not for the secondary leaves.	
5-11-07	Too much rain has also added blanks. Several young seedlings have rotted and died. Blanks will be filled up when fine weather sets in.	
25-11-07	Blanks have been filled up by planting seed and in a portion where there were too many—resowing was done, being found economical.	
25-12-07	The crop is doing well. Weeding was done with more labour than usual, conditions having been favourable to the growth of weeds and untimely for their favourable removal.	
5-1-08	As is characteristic of Uppam, the field at present looks healthy and vigorous and is steadily progressing, the weather having been clear and almost rainless.	
20-1-08	The recent rains have done much good; no more will be required till the 1st picking is over. It is now flowering here and there.	
29-1-08	Here and there some caterpillars (leaf-eaters) and horned bugs are noticed, but the present conditions of the weather do not appear to favour their increase. The plants are here and there attacked with Buttermilk disease.	
9-2-08	The crop is growing, and flowering is general on the high ground.	
1-3-08	Flowering general, except in resown portion. Stray bolls are bursting. It is to be noted that this field, though sown at the same time as Nos. 27 and 28, is more than a fortnight later. Here and there occur intermediate plants known as "Vellai Karunganni." The late sown portion has been thinned and reserved for Professor Gammie's selection of typical plants.	
30-3-08	Heavy picking. The plants are bending with the load of bolls. A good crop is expected. Recent rains hampered picking considerably.	
27-4-08	The plarts have flushed for the summer picking.	
15-7-08	The summer picking is almost over; the yield is disappointing.	

MAP SHEET OF FIELD NO. 21, FOR THE UPPAM COTTON CROP, KOILPATTI AGRICULTURAL STATION, 1907-1908.



29th *January* 1908.

a. The plants are tolerably good though not uniform in height.

b. Resown portion. The crop here is not so advanced as the remaining portion--here too the northern strip is sparse.

c. The plants are healthy, uniform and vigorous.

d. This portion is patchy owing to surface wash and stagnation of water. There is a band of land across the N. and W. boundaries where the crop is thin. The plants too are stunted and puny and have not grown well.

SUGAR-GROWING AND MANUFACTURE IN NORTHERN INDIA.

By C. J. MACKAY,

Superintendent, Cawnpore Sugar Works.

Several attempts have been made in recent years to manufacture white sugar direct from sugar-cane as is done in the West Indies, Egypt, Mauritius and other sugar-growing countries.

Considerable capital has been invested in these undertakings, the best up-to-date machinery imported from Europe, and skilled Europeans with expert knowledge, commercial, technical and scientific, have been employed. In spite, however, of what would appear to be most favourable auspices, careful supervision, and a very large demand for the manufactured article, none of these undertakings have so far achieved more than a very moderate success, and most have had to face serious pecuniary loss.

At first sight, no country in the world would appear to offer a better field for the cane and sugar industry than India. The consumption of sugar by the inhabitants of this country is enormous, and upwards of half a million tons of sugar are imported into India annually.

Why then has the sugar-making industry not made better progress? Various causes have contributed to handicap these pioneer efforts. Although sugar-cane has been grown throughout Northern India for some 2,000 years, the quality of the crop has never been as high as in other cane-growing countries, either as regards the weight of cane grown per acre or the sugar contents per 100 of canes.

The Indian cultivator, at his best, is hard to beat, although his methods and implements may appear primitive to Western agriculturists. He is quick to adopt improvements in cultivation

and seed, if he is satisfied that they will increase his profits ; but in the growing of sugar-cane, he is faced with two serious problems.

The soil has been exhausted by many centuries of continuous cropping, and the supply of suitable manures at a moderate cost is very limited. A greater difficulty still is the climate. The annual rainfall, though usually sufficient in quantity, is badly distributed throughout the year, being concentrated into a few months, followed by many months of extreme dryness.

These two causes, however, would not alone be sufficient to account for the indifferent success of large central cane factories ; fresh sources of manure can be discovered, and the short period of growth, due to the concentration of the rainfall, can be mitigated by carefully thought-out schemes of irrigation.

The Indian cane factory has against them, on the credit side, the saving in manufacturing losses by a continuous process, and the economy in freight and transit charges by having a ready market at their doors.

The greatest difficulty, however, with which a central cane factory has to contend is the nature of Indian land tenure, by which the country is split up into a multiplicity of small holdings, and this seems to be an insuperable one. The effect of this system of cultivation in innumerable small farms is that concentration of crop round the factory is, in most instances, impossible. The cane is grown in small isolated patches, and in order to feed a large factory, cane has to be collected from a very large area radiating many miles from the factory, with all the consequent heavy cost of handling and carrying entailed in dealing with a commodity so heavy and bulky as raw sugar-cane ; this combined with the inevitable deterioration and loss of sugar by inversion during the period of transit from the fields to the mill more than counterbalance the benefits gained by the continuous process.

It would seem, therefore, that central cane factories can only be profitably worked, if at all, in Canal Colonies or large zamindaries where a concentrated area is available under the personal control of the owner or planter.

If the sugar industry in India is to hold its own against the foreign importer, development will have to be along the line of intense cultivation by the grower to increase the outturn of sucrose per acre and improvements in the making of raw jaggery or *Gul* by the villager, preventing the heavy losses by inversion and adulteration entailed by the crude methods at present employed. If this can be done, the Indian refiner will have nothing to fear from foreign competition in India, and may even in time be able to export to other markets, if not barred by prohibitive protective duties.

IMPROVEMENTS IN PADDY CULTIVATION ON THE COURT OF WARDS' HOME FARM AT SIVAGIRI, TINNEVELLY DISTRICT, MADRAS.

By J. M. LONSDALE, N.D.A., N.D.D.,

Agricultural Expert, Court of Wards, Madras.

SIVAGIRI is situated about 12 miles, as the crow flies, north-west of Sankaranakoil and about 6 miles from the foot of the Ghauts. The average rainfall is about 25 inches per annum. The Home Farm consists of 252 acres of wet land under four tanks, besides dry and *peramboke.** The soil under tank irrigation varies in texture from sandy to clayey loam, the sub-soil is clayey and overlies a bed of nodular limestone. Some of the land is very much subject to drought, whilst other portions were originally saline, but have now been much improved. The farm has been under the management of the Court of Wards for a considerable number of years, but it was not until M. R. Ry. Rama Rao became Farm Superintendent about eight years ago, that the operations were begun for introducing improvements in the cultivation of paddy for which this farm has become famous by reason of the success attained.

2.—LINES OF IMPROVEMENT.

The lines upon which improvements have been introduced are briefly reviewed below.

(1). *Ploughing*—The ordinary wooden plough has been almost superseded by an iron plough made on the same principle as the local wooden plough. These iron ploughs are used both for ploughing dry and in puddle, and it is surprising with what

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* Common land not liable to assessment is called *peramboke* in the Madras Presidency.

ease the small farm cattle seem to pull them and the ploughmen (when at least they have become accustomed to them) prefer them to the old wooden plough, because three ploughings with this iron plough produce quite as good a tilth as five with the wooden one. The action of this improved plough is to cut the soil into slices or furrows and turn the furrows over face downwards, thus burying the weeds for the sake of which it is necessary to plough so often with the wooden plough. These iron ploughs are made by the village blacksmith from old ships' plates bought from Rajapalayam in the Srivillputtur Taluk. The total cost, without draught and yoke poles, is about Rs. 6, and anyone who wishes to purchase one may order the same from the Farm Superintendent.

(2). *Manuring*—It is well known that paddy is a crop which exhausts the soil, and (if the irrigation water is not heavily ladened with silt) manure of some kind must be put on every year if good crops are to be obtained. Experiments carried out from year to year at Sivagiri show that the best and cheapest manure for paddy is that obtained from the dung, urine and litter of animals, which has been properly preserved whilst rotting, commonly known as farm-yard manure. On this Home Farm all the manure which can be conveniently collected both on the Farm and in the village, is gathered up every day and put into pits and well mixed up with litter and refuse and left until it is sufficiently rotted. Whilst rotting, it is occasionally moistened with water or urine to make it rot more quickly and in order to prevent its becoming too heated. To protect it from the scorching sun, it is kept covered with a layer of tank silt or soil. Because of the immense quantities of cowdung used for fuel, and also because the farm livestock of this country are so poorly fed, the amount of farmyard manure available is by no means sufficient to maintain the fertility of the paddy lands up to an average standard. It is, therefore, absolutely necessary to devise cheap and convenient methods of obtaining other kinds of manures besides farmyard manure, and this branch of investigation has received a great deal of attention at Sivagiri and with great

success, judged by the steady increase in the average returns obtained per acre from year to year. The additional manures which have been tried and can be recommended are :—

(*a*) *Green leaves* from plants which are useless for fodder, such as wild castor, *kolingi* (*Tephrosia purpurea*), etc., which grow in such large quantities on the waste lands. Provided they grow thickly within a short distance from the land to be manured, they form cheap manure, but such manure becomes too expensive if the above conditions do not exist.

(*b*) Castor, *Neem Punnai* (*Calophyllum inophyllum*) and *poonacs* are also good manures and cheap if they have not to be brought from long distances by rail.

(*c*) Undoubtedly, however, the greatest success has been attained by the cultivation of *leguminous* crops on the wet land itself during the dry season and the season in which there are only occasional showers of rain. Leguminous crops are those which do not exhaust the soil of its plant-food ; on the other hand, it is found that they actully *increase* the amount of plant-food in the soil. The leguminous crops which are commonly cultivated in this country are groundnut, horsegram (*Kulthi*), red gram (*Dhol*), cowgram, black gram, Bengal gram, muchai bean, and sann-hemp (*Crotalaria juncea*). There are also many leguminous plants which grow wild in the jungles in great quantities, such as *Kolingi*, *avarai* (*Cassia auriculata*), *Cassias* (*Cassia tora*, *Cassia sophera*, *Cassia tomentosa*), *Poongam* (*Pongamia glabra*), *Vathamadaki* (*Poinciana elata*), *Vagai* (*Albizzia lebbek*, *Albizzia procera*), *Usil* (*Albizzia amara*), *etc.* *Kolingi* and sann-hemp are the two leguminous crops which have been grown as green-manuring crops on the wet lands at Sivagiri.

It will be well to give a short account of the cultivation of *Kolingi* at Sivagiri. The seed is gathered from the waste lands when ripe about the month of July. Coolies are paid one measure of paddy for one measure of thrashed *Kolingi* seed. It is then kept in a dry place and occasionally dried in the sun till *pishanum* (winter) paddy is harvested in February, March or April. As soon as possible after a plot has been harvested, the

land is ploughed once, and if the soil is hard, it is cross-ploughed also. If the soil is so dry and hard as to prevent ploughing immediately after harvest, then every opportunity is taken of ploughing after the showers of rain which usually fall in April and May, but the earlier the land is ploughed and the seed sown, the better will be the germination. Three to five heaped Madras measures are then sown broadcast, and it is covered by ploughing once and cross-ploughing with a light wooden plough. No further cultivation is necessary at this stage. It must not be irrigated. The crop is allowed to grow till August or September when every opportunity should be taken of ploughing once through the crop in the dry state after the showers of rain which usually fall during these months, in order that weeds may be destroyed and the soil aerated. *Kolingi* is deep-rooted, consequently little of it is uprooted by the plough, and the uninjured plants will grow much better, and seeds previously buried too deep or too shallow will germinate. In October irrigation water becomes available, the plots of *Kolingi* are then flooded and ploughed in puddle. If the *Kolingi* is very thick and the plants tall, it is advisable, after flooding but before ploughing, to pull the *Kolingi* up by the roots and spread evenly over the plot. It is then easily trampled in by ploughmen and cattle whilst puddling. Thus, by spending about 6 annas on seed and doing a little extra labour in the dry season when the work on the farm is slack, a saving of 10 to 15 rupees per acre for *poonacs* or jungle leaves can be made and often a great deal of time is saved, and all big *ryots* know how important it is not to be late in the transplanting of paddy. *Kolingi* grows best in light loamy soils. It does not thrive well in stiff clays or land which is water-logged.

(*d*) *Sann-hemp* (*Crotalaria juncea*) is a quick-growing crop, especially suitable for the green-manuring of wet land which has borne a *kar* or summer crop. A crop of sann-hemp, 3 to 7 feet in height, can be obtained in from 4 to 8 weeks. It is a rain-fed crop, but if there is no rain, it may be irrigated with about one inch of water every 10 days. It is largely grown as an

unirrigated second crop after paddy in the Kistna and Godaveri Delta lands. It is a most excellent fodder for cattle if cut when from 5 to 7 weeks old and sown about 20 Madras measures per acre (the capacity of the Madras measure is 62·5 fluid ounces). When cultivated for green manure at Sivagiri, it is sown at the rate of 12 Madras measures per acre in August or September after the land has been ploughed. It is then covered by two light ploughings, and if there is a little moisture in the soil, it germinates in about 3 days. No further cultivation is necessary. Before the plots are flooded in October or November, the sann-hemp is cut and bundled, and the bundles are led on the bunds on each side of the plot. The plot is either ploughed dry or in puddle. Then the sann-hemp is taken and spread evenly over the plot. It is then trampled in. Nothing then remains to be done but levelling the plot and transplanting immediately. A plot of land, about 6 acres in extent, on the Home Farm, which had never been known to give more than 700 Madras measures of paddy per acre, was sown with sann-hemp on the 1st of September 1906; by the 1st of October it was an average height of 3 feet. It was ploughed in when 7 weeks old, and the outturn of paddy from that plot was 1,225 Madras measures per acre. Even if the sann-hemp is cut for fodder, the roots and stubble left behind do undoubtedly make the soil richer in plant food than it was before the crop was sown. When sann-hemp is required for seed, it should be grown on *dry* land; otherwise the sann-hemp raised from that seed will not be able to resist drought so well. When grown for seed, a most excellent fibre is obtained from the straw.

(*e*) Another most excellent manure available in large quantities at Sivagiri is *tank silt*. It is applied alone to saline lands on the Home Farm which have been greatly improved thereby. It is also mixed with the farmyard manure. This silt is dug up from the tank bed and thrown down the outer side of the tank bund at a cost of one anna per cubic yard.

(3). *Irrigation*—The most important factor in the successful cultivation of wet paddy is the possession of a sufficient supply of

irrigation water from the time of transplanting up to the time when ripening is well advanced. It has long been considered by some, however, that the quantity of water said to be necessary to grow a crop of paddy, according to the variety of the paddy and its environment, is far too large. It was with the object of trying to prove the truth of this that experiments have been carried out for the last 3 or 4 years at Sivagiri. The results of the experiments go to show that a grievous waste of water does occur when paddy is irrigated according to the customary method at Sivagiri. Quite as good crops have been obtained in many cases with 30 inches of irrigation water as with 60 inches, provided the former amount is used judiciously. In the case of a five-months crop of paddy transplanted one month after sowing in nursery, it is customary to keep the plots deep in water after the transplanted plants have picked themselves up, in order that weeds may be smothered. It is well known that paddy can have too much water known as *neer-shavi* (water-choked crop). If the wet land was ploughed in the dry season or even a month or so before the time for puddling, as nursery beds are, the weeds would already be killed and would not require drowning with water, and much of the water which runs to waste at this time would be saved up in the tank or canal. Even when the weeds are killed, it is customary to still keep the plots deep in water, and it is only a short supply running from the sluice gates which forces a reduced level in the plots; the result is that, if the supply of water fails, paddy grown under these conditions almost immediately succumbs to drought, but it is found that paddy irrigated and then allowed to become almost dry between each application of water, can withstand drought for a longer time. Large areas of paddy have been grown in seasons of scarcity on the Home Farm by not letting irrigation water into the plots until the surface of the soil had just begun to crack.

(4). *Single planting of paddy seedlings*—This is a question which affects most of the South and West of this Presidency and some parts of the North also. When it is considered that

there are about 74 lacs of acres of wet land in the Presidency, the ways and means of reducing the amount of paddy seed used per acre must necessarily be of great importance to most of the ryot class. It has been proved conclusively at Sivagiri that the amount of seed used per acre can be enormously reduced (*without reducing the yield*) by transplanting single seedlings instead of a bunch varying in number from 2 even up to 20. This is because the paddy plant possesses the property of throwing out new shoots when planted *singly*, but which does not occur to any great extent when paddy is planted in bunches. It is difficult at first to teach the coolies to plant singles, but when this has been done, there is a direct saving at least equal to the value of the seed saved, as there is no extra cost for labour. One point, however, until recently, has been overlooked, *i.e.*, the rate per acre at which seed is sown in the seed-bed must be reduced to at least 100 Madras measures per acre in order that the roots of the seedlings shall not be so closely matted together ; otherwise, the transplanting coolies cannot separate them easily into single seedlings. The average seed rate on this Home Farm last year was 16 Madras measures per acre or nearly 40 pounds of seed, and it is hoped that it will be possible to still further reduce this quantity to about 8 Madras measures per acre when the coolies become more expert. This characteristic of throwing out new shoots is called 'tillering.' Most varieties of paddy in the South have partially lost their powers of tillering ; but it has been observed that these varieties, if they are planted singly year after year, gradually regain the power to tiller.

(5). *Introduction of New Varieties*—A number of excellent varieties of paddy have been introduced from Northern India and elsewhere. The characteristics of these new varieties have been studied, and seeds specially selected and stored for sale to the public. A number of these varieties, *e.g.*, *Swarnavari* and *Banku*, are particularly good, because although they are paddies of fine quality and good yielders, yet they are early-maturing and are good resisters of drought. The reason why they possess these qualities is because these varieties have been grown for a long number of

years in parts of India where the atmosphere is exceedingly hot and dry, and where irrigation water is never very abundant. It is important to remember that such varieties gradually lose these characteristics when they are grown in a locality where the air is damper, and where they receive much more irrigation water than they have been accustomed to. This makes it necessary to get *new seed* every five or six years from the country where the variety originated.

(6). *Seed Selection*—Seed is specially selected every year from the local varieties of paddy which prove most profitable and also from the introduced varieties. This is used as Home Farm seed the following year. Some selected seed is also available for sale to ryots. If a large quantity of selected seed of any particular variety is required, an order should be sent to the Farm Superintendent early, *e.g.*, if it is *pishanum* (winter) paddy, order not later than January ; if it is *kar* (summer) crop, not later than June. The selection is done by picking out the best ears immediately before or after the crop is cut. These are bundled and thrashed separately, and the seed is carefully dried in the sun and stored in large earthenware pots. Special attention is paid to picking out ears which are quite true to the variety and quite free from disease. Care is also taken that all the grains in the ear are fully ripe and close-set. An ear is rejected if many of the grains have already been shed from it and also if the glume or outer skin of the grain is empty. Seed is not usually selected from crops growing on patches of ground which are badly drained, even though the ears thereon are good specimens of their kind, unless it is a variety of paddy which is specially suited for water-logged soils like *Kulavalai* paddy. On the other hand, ears are picked from a crop growing on a plot which has been subjected to drought, even though the ears are not quite so large and good as ears of the same variety growing on a plot which has not been subjected to drought. One of the chief points to be considered in the selection of most varieties of paddy seed is to try and increase the *drought-resisting* power of the variety even though the yielding power is slightly decreased.

(7). *Dry Cultivation of Paddy Lands*—Except on very sandy and very poor soils the dry cultivation of wet lands has been found to have a very good effect. If ploughmen and bullocks can be spared from the work of thrashing, carting the grain and stacking straw, the plots are ploughed immediately the crop is taken off the ground provided the soil is not already too hard. If these cannot be done, the land which is not cultivated with *kar* crop paddy is ploughed whenever there is an opportunity after the occasional showers of rain which fall from the beginning of April to the end of September. The main effects of this dry cultivation are:—

(*a*) More plant-food is rendered available for the succeeding crop.

(*b*) The air gets into the soil which enables the roots of paddy to go down deeper, thus making it less subject to drought and increasing the area from which the plant obtains its food-supply.

(*c*) Weeds are destroyed.

Many ryots ask 'how will the cattle be fed if the wet land is ploughed up during the dry season?' The reply is that more is lost in paddy than is gained in grass, and the shortage in grass must be replaced by the growth of sann-hemp and other valuable fodder crops, which can be grown at a very small cost and preserved in stacks until required.

3.—VARIETIES OF PADDY GROWN AT THE HOME FARM, SIVAGIRI.

A short account of the different varieties of wet land paddy grown at Sivagiri may prove useful to agriculturists who wish to buy seed from the Home Farm. Brief notes will be given indicating whether—

(*a*) the variety is a *pishanum* or *kar* crop;

(*b*) the average duration of the crop from the time it is sown in the seed-bed to harvest will be given in months;

(*c*) the quality of the grain from the rice merchant's standpoint will be given as 'fine,' 'coarse,' 'medium,' etc.

Manalvari is both a *kar* and *pishanum* crop, four months, coarse-grained, local variety, yielding reddish-coloured rice. Average yield for *kar* crop of 1907 was 944 heaped Madras measures per acre. (A heaped Madras measure is equal to 68·75 fluid ounces.)

Chitraikali is a *kar* crop, three months, coarse-grained, local variety, yielding white rice ; average yield for *kar* crop of 1906 was 875 heaped Madras measures per acre. The rice does not break easily when husked raw.

Halki being a recently introduced variety ; the proper season is not yet known. It is a four-months, fine, scented variety, yielding during the *pishanum* season of 1907 and 1908 at the rate of 918 heaped Madras measures per acre. This variety has long spikes or awns on the ear head.

Banku is a four-months variety, said to have been introduced from Nagpur in the Central Provinces ; fine, long, slender grain, straw of superior quality, tillers well, withstands drought, easily husked, and the rice is gummy, *i.e.*, it contains a good percentage of muscle-producing food. A crop grown in the *pishanum* season of 1905 and 1906 on a plot measuring 5·07 acres yielded at the rate of 1332 heaped Madras measures per acre and 1,600 lbs. of straw per acre. The land was prepared solely with improved ploughs and was manured only with a *kolingi* crop grown on the plot. The seed was sown on October 10th, and transplanting, in single seedlings, one span apart, was begun on the 10th of November, and harvest started on the 9th of February. The grain was sold at 10 to 11 Madras measures per rupee. During the last two months, water being scarce, the surface of the soil was just kept black with moisture.

Badshabhog is a 4-months, introduced, fine, slightly scented variety from North India. The rice is small, and being short, the husk is removed without breaking the grain. Tillers well. In the *pishanum* season of 1906 and 1907 it yielded at the rate of 1,012 heaped Madras measures per acre.

Swarnavari is a three and-a-half months variety, newly introduced from Cuddalore. It may be grown either in the *kar* or

pishanum season. The average yield of the *kar* crop in 1907 was 897 heaped Madras measures per acre and 954 Madras measures during the following *pishanum* season. The rice is white, and the straw is superior in quality, remaining more or less green right up to the time of harvest.

Poombalai is a *pishanum*, five-months, local variety, with grain of medium quality. The average yield during the *pishanum* season of 1907 and 1908 was 997 heaped Madras measures per acre.

Kulavalai is a six-months, coarse-grained, *pishanum* crop, suitable for submerged and water-logged land.

Anaikomban is a six-months, fine-grained, *pishanum* variety. It is considered the best quality local variety. The average yield during the *pishanum* season of 1906 and 1907 was 1,150 heaped Madras measures per acre.

4.—The Returns for Paddy Cultivation at Sivagiri for the year ending 30th April 1907.

The average yield of paddy per acre for the *kar* crop which was cultivated only on 127 acres was 890 heaped Madras measures. The corresponding yield for the *pishanum* crop cultivated on 252 acres was 886 Madras measures. If the two crops are added together, it will be seen that each acre of wet land on the Home Farm yielded during the year at the rate of 1,340 Madras measures. Calculating the value of the paddy at Rs. 9 per 100 heaped Madras measures, the value of the paddy produced on the Home Farm during the year was Rs. 30,484. The value of the average yield of each acre, *viz.*, 1,340 Madras measures, was Rs. 120-10. The cost of production was also carefully worked out. As practically the whole of the Home Farm receipts are obtained from paddy, the whole of the working expenses for the year were charged to paddy. The cost of production of 1,340 heaped Madras measures being approximately Rs. 37. The cost of producing 100 Madras measures of paddy was Rs. 2-12. The net profit per acre was Rs. 83-10. This latter figure being obtained by deducting the cost of production per acre from the value of paddy which each acre yielded

during the year. The above figures show that paddy can be made into a very profitable crop even on a farm under public management where the cost of labour is necessarily higher than it would be if the land was farmed by the zemindar or by a ryot.

THE AGRICULTURAL SECTION OF THE NAGPUR EXHIBITION, 1908.

BY G. A. GAMMIE, F.L.S.,

Imperial Cotton Specialist:

AND

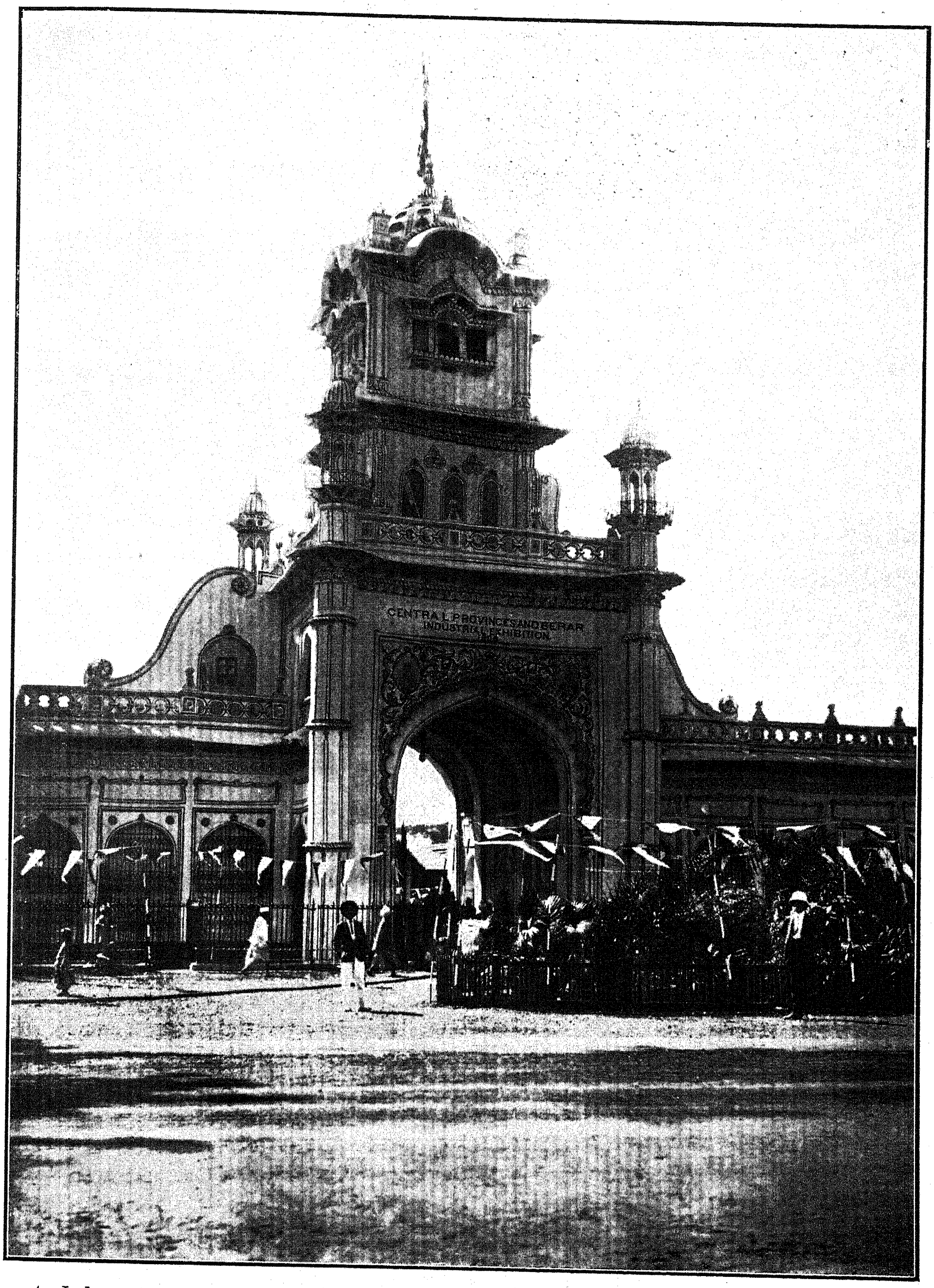
E. SHEARER, M.A., B SC.,

Imperial Agriculturist.

FROM the admirably arranged official handbook to this exhibition, we learn that the first Nagpur Exhibition was opened on the 26th December 1865, about three years after the establishment of the Central Provinces, as an integral part of the Indian Empire. In 1866 another exhibition was held at Jubbulpore for the instruction of the inhabitants of the northern half of the provinces. This was, of course, in ante-railway days when intercommunication between distant parts was maintained with difficulty. It was the original intention to continue with a series of exhibitions at short intervals, but this idea was never carried into effect, so that the present is but the second Exhibition at Nagpur. During the long interval of forty-three years that has elapsed, an enormous expansion has occurred in the population, trade and material prosperity of the country.

The present exhibition is the outcome of a meeting held on the 2nd December 1907, by a number of influential gentlemen representing all parts of the Central Provinces and Berar, when a large sum was subscribed on the spot, and a strong organising committee was formed. Altogether Rs. 90,000 were received from private sources. Government gave a grant of Rs. 50,000, and Dewan Bahadur Kasturchand Daga generously gave the magnificent sum of Rs. 25,000 to defray the cost of building a fine stone

PLATE XIV.



A. J. I. MAIN GATEWAY TO THE EXHIBITION.

PLATE XV.

A. J. I.

General View of the Exhibition.

pavilion of pleasing architecture, which will remain as a permanent memorial of the Nagpur Exhibition of 1908. (Plates XIV & XV.)

Seventy per cent. of the population of the Central Provinces is directly engaged in agriculture, and a considerable proportion of the remainder is, in a large measure, dependent on it. It was fitting, therefore, to find that the agricultural section was one of the largest and most complete in the exhibition. The entrance to the section (Plate XVI) was emphasised by a triumphal arch carefully worked out in detail by Mr. D. Clouston. The decorations were composed of heads and sheaves of the principal crops and paintings illustrating improved methods of cultivation recommended by the Local Agricultural Department. The latter was responsible for the biggest share of the exhibits, but there was also a large number shown by the departments of other provinces, notably that of Bengal, and by private firms and individuals. Taking those of the Central Provinces Department first, we found them grouped into three main classes: (1) soils and manures; (2) crops and their products; and (3) implements.

In the first class were shown samples of the various soils of the provinces, and a collection of natural and artificial manures. Some of the soils were divided up to show the relative proportions of the important constituents, and the water-absorbing capacity of various soils was demonstrated. There were also pot cultures of field crops, such as rice and cotton, illustrating the effect of variety and manurial treatment.

Coming next to the crop section, we found very full collections of rices, jowars and wheats, accompanied by chart, showing graphically the results obtained by different methods of cultivation; sugarcane, a crop which is being fostered by the department, was represented by excellent samples of Red, Green, Ashy and Striped Mauritius, Gilman's Red Sport and Pundia. The exhibits of cotton, a crop of major importance on which the prosperity of the provinces largely depends, were specially interesting. The map which accompanied the exhibits showed that with the exception of a small strip abutting on the Nizam's dominions where "Bani," a superior race, is grown, the bulk of the cotton

is derived from a coarse but prolific variety known as "Jari." Research has disclosed the fact that this is not a pure crop, and that in the mixture a better form does exist, and steps are being taken to encourage the cultivation of the latter. The Upland Georgean is not very promising, but the "Bhuri Kapas" introduced from Singbhum in Bengal gives much promise. The exhibits of maize, bajra, millets, pulses, oilseeds and oilseed residues, fibres, fodders and garden crops, call for no special remark.

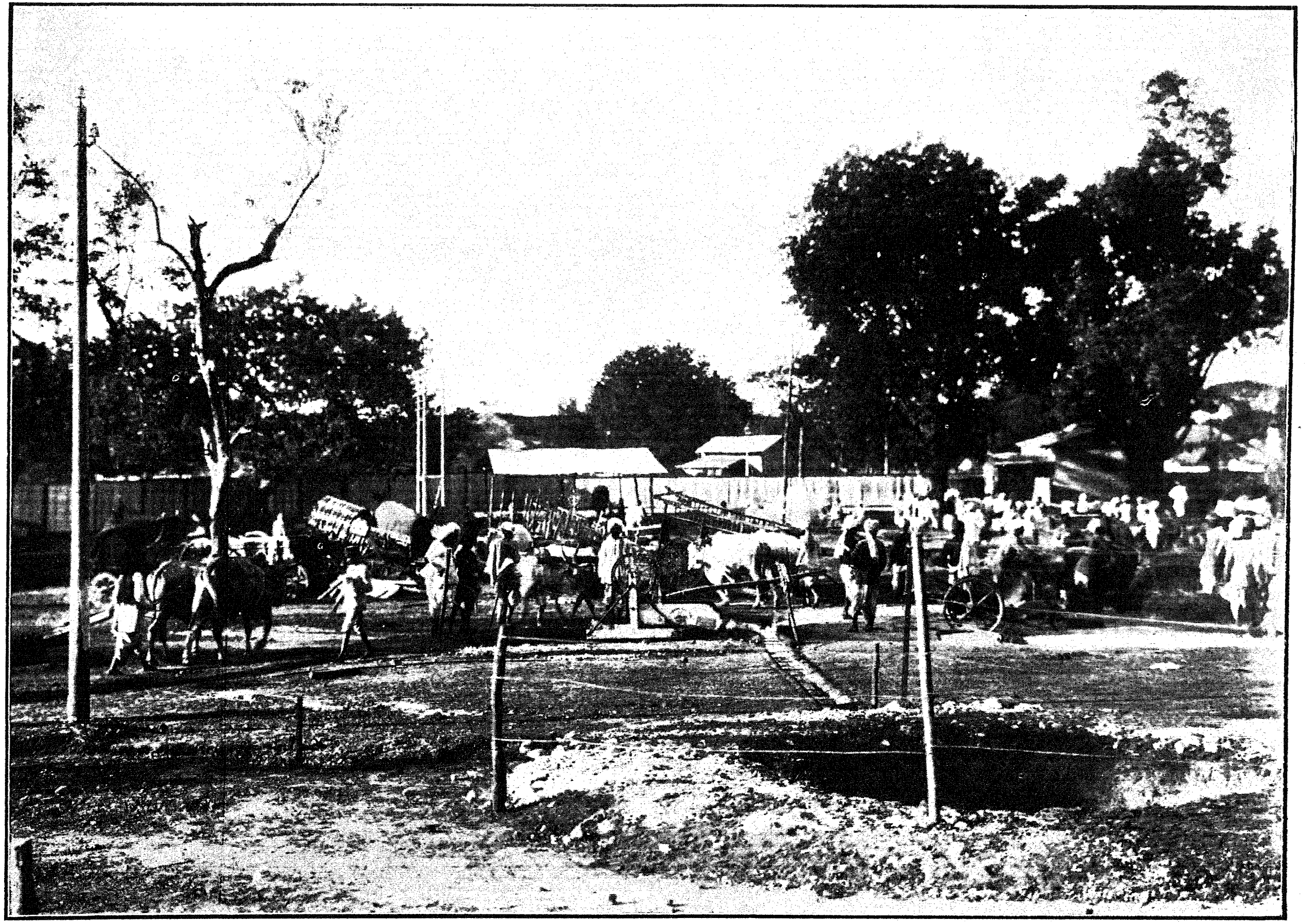
The implement and machinery section (Plate XVII) attracted much attention from visitors, and deservedly so. On a convenient open space of ground the department had arranged a collection of improved ploughs, drills, chaff-cutters, thrashers, winnowers, chain pumps, cotton gins, sugarcane mills, hay presses, flour mills, maize shellers, etc., and also a complete installation to demonstrate the Hadi process of sugar manufacture. Each day from 3 P.M. to sunset all these implements and machines were worked under the close personal direction of Mr. Clouston and a staff of assistants. With the co-operation of the District Agricultural Associations, selected batches of cultivators from all parts of the provinces were brought in on fixed dates, taken charge of by assistants of the Agricultural Department and shown over the exhibition and the Nagpur and Telinkheri Farms. Lectures were also delivered describing the agricultural improvements recommended by the department. Numerous orders for certain of the implements and machines shown, were booked on the spot, but apart from this the educational value of the demonstrations must have been of a very high order.

The Turnwrest ploughs, which for some time past the department has recommended for breaking up black cotton soil in the hot season and for the eradication of Kans, command a steady sale. The department showed a more recent type of plough obtained from Messrs. Ransome, which they believe to be an improvement on the Turnwrest for heavy work in black cotton soil. The Harder winnower sold by the department at Rs. 123 was doing good work and seemed well adapted to the conditions of the provinces. Two threshers, Mayfarth's and Harder's, were

PLATE XVI.

A. J. I. ENTRANCE GATEWAY TO AGRICULTURAL SECTION.

PLATE XVII.



A. J. I.

AGRICULTURAL MACHINERY AT WORK.

shown. These worked fairly well, but there is little demand for this sort of machine at present. Amongst fodder-cutters Harder's No. 10 is recommended by the department.

Of the water-lifting appliancos the chain pumps attracted most attention. The hand pump (cost Rs. 55) worked by two men is said to raise 1,600 gallons per hour to a height of 12 feet. The double chain pump (cost Rs. 110) worked by a pair of bullocks and bullock gear (cost Rs. 102) will raise 6,000 gallons per hour to a height of 20 feet. It seems to us that, where the lift is not beyond this, oil engines, with their big initial outlay, cost of running and heavy depreciation in unskilled hands, will find it difficult to compete with such an economical form of water-lift.

In addition to their own exhibits in this section the department tested those sent in by firms and individuals. A three-roller iron sugarcane mill (Plate XIX) from the Nahan Foundry, Punjab, struck us as being the best mill of the kind which we had seen. The workmanship is good, and the cost (Rs. 110 with rollers $8\frac{1}{2}'' \times 8\frac{1}{2}''$) is moderate. A good flour mill (Plate XIX) worked by a pair of bullocks (cost Rs. 150) was shown from the same foundry.

Messrs. Burn & Co. had a good show of power machinery, including engines, pumps, rice huskers and a large agave decorticating machine suitable for plantation work. They were awarded a Gold Medal for their exhibits as were also Messrs. Marshall, Sons & Co. for a similar series.

Mr. Winsor, of Sirur, in the Poona district, exhibited two small fibre machines suitable for agaves or plantains. One, the Daw decorticating machine, requiring one man to operate it, and said to produce an average of 25 lbs. of fibre a day, is sold for Rs. 75. The other, the saw fibre machine, is sold in three types, a hand machine for Rs. 125, a double machine for power at Rs. 500, and a quadruple machine for power at Rs. 750. The last run by a two-horse-power gear is said to yield 250 to 500 lbs. of fibre per day of ten hours, or from 30 to 125 lbs. per day for each wheel. It requires four men to feed the machine, besides those engaged in bringing leaves, etc. These two machines are worth testing by owners of small plantations.

Several modifications of country ploughs, drills and hoes, were shown by cultivating natives of the Central Provinces. These are worthy of remark, not so much on account of their individual merits, though in one case, where to the ordinary drill an attachment for covering the seed had been added, the idea was good and worked satisfactorily, but as showing that, as a result of the work of the Agricultural Department, the people are realising that their old methods are capable of improvement and are themselves doing something towards this improvement.

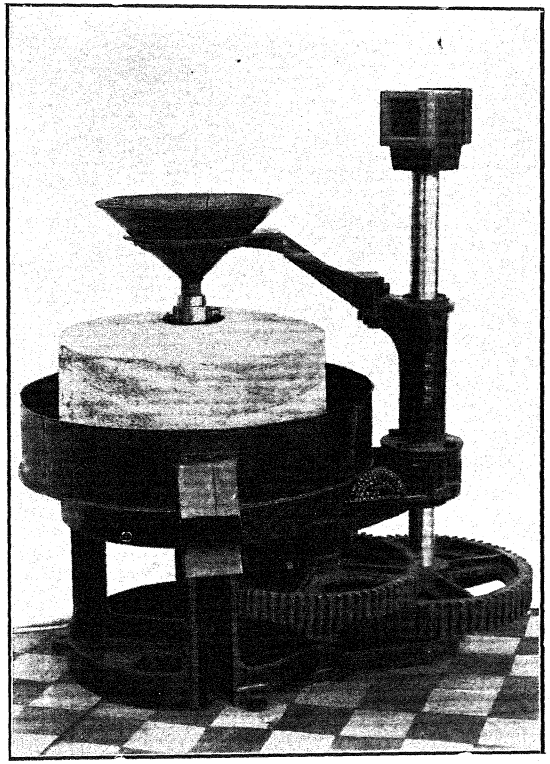
Of the exhibits sent in by the various provinces only the collection shown by the Bengal Agricultural Department calls for special remark. This was particularly complete and well arranged and reflects great credit on Mr. Woodhouse, who, we understand, was responsible for getting it together. The sets of ordinarily grown cereals, pulses and other field and garden crops were probably complete. As a result of the experimental work of the Bengal Department, they are able to recommend certain varieties, such as Saran jowar, Jaunpur maize, Dumraon oats, Saran rahar, Patna gram, Cuttack groundnut, Raipur and Jubbulpore mustard, Kakya, Bombai, Hewti and Deswal jutes and Naini Tal potatoes. Seeds of these can be obtained on purchase from the department's godown. There was a complete set of jute fibres (including some specially good samples sent in by Mr. Finlow), a large variety of materials used in tanning and dyeing, and a good collection of grasses and seeds used in basket-work and mat-making, paper and rope manufacture. Of the cottons shown, *Buri*, an acclimatised form of Upland Georgean grown in Singhbhum, was the best. The famous Dacca muslin was probably made from the *Jaria* of Bengal. (Plate XVIII.)

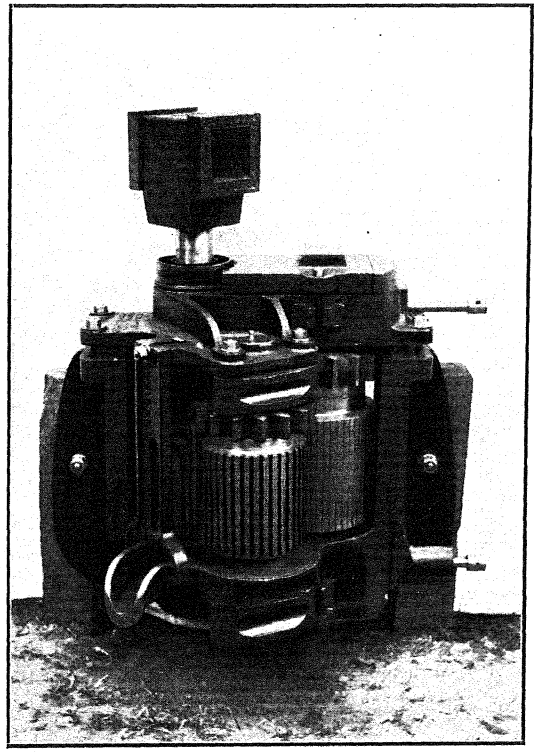
What materially added to the value of the Bengal exhibits was an excellently prepared series of maps and diagrams clearly illustrating the rainfall and the distribution of the principal crops throughout the province, the results of manurial trials and of experiments in spacing in transplanted rice. The Bengal Fishery Department showed, in a glass aquarium, several kinds of tank fish which are said to breed and grow rapidly in tanks and

PLATE XVIII.

BENGAL CROP EXHIBITS IN AGRICULTURAL SECTION.

PLATE XIX.





A. J. I. FLOUR MILL—NAHAN FOUNDRY.

SUGAR MILL—NAHAN FOUNDRY.

marshes and to be nourishing as food. In the sericultural branch, besides examples of silk cocoons, there was a silk-reeling machine from Berhampore, shown in operation by an ordinary villager, assisted by a small boy, a silk loom from Murshidabad and samples of silk in all its stages.

For the special agricultural week in the middle of December there had been arranged a Cattle Show and Bullock Races. The Cattle Show was distinctly disappointing. The prizes offered, though large and numerous, attracted few entries, and these were certainly not representative of the best types of cattle to be found in the Central Provinces; as a matter of fact, most of the entries came from the immediate neighbourhood of Nagpur where the cattle are not very good. The well-known Malvi breed was not represented at all, while only one pair of Berari cattle was shown. The bullock races, on the other hand, were very successful. The keenness of the natives of the Central Provinces on this form of sport is shown by the fact that, for one of a pair of bullocks that competed, his owner had given Rs. 600. This high figure was justified by his success in the races.

In concluding this brief and imperfect account we would congratulate the Central Provinces Agricultural Department on an Agricultural Exhibition which was probably the most successful ever held in India, and which might well serve as a model for similar exhibitions in other provinces. It is not too much to say that this result was due mainly to the efforts of Mr. Clouston who was indefatigable in organising the exhibition and in making it a success after it had been opened.

Readers who are interested in the other sections of the exhibition will find much useful information in the Official Handbook.

PUNJAB GARDEN HEDGES.

By W. ROBERTSON BROWN, F.R.H.S.,

Superintendent, Agri-Horticultural Gardens, Lahore.

In some of the more important stations of the Punjab, hedges meet the eye in every direction. The Mall and some of the less important roads have hedgerows: in many bungalow-gardens, there is quite a maze of hedging.

These hedges are generally fairly shapely, yet ragged and unsightly examples are not infrequent.

There has been a tendency during the past few years to plant too freely, and the charm which bright trim hedging lends has been somewhat detracted from by injudicious use. Just as the *mali* crowds as many purposeless little paths into the garden as he possibly can, so he is inclined to introduce a hedge wherever a hedge is possible. Much valuable time which might, with advantage, be devoted to the eradication of weeds from the lawns or to other necessary work, is frittered away in the maintenance of unnecessary hedges and paths.

Invariably, hedgerows disappear with the outlying bungalow of each station; living hedges are not favoured by the agriculturist, and when it is remembered that these afford excellent breeding ground to rats and other ground vermin, he is probably right in his avoidance of the possible evil.

I will discuss chiefly those plants which are popularly used with the object of gaining firm, unbroken hedgerows. The rose and the Bougainvillœa can hardly be classed as true hedgerow plants. These are straggling in habit; they have not stiffness; they are liable to be "gappy." Lime, Dodonœa and Duranta, on the contrary, are examples of the most amenable hedgerow subjects.

For ornamental work our ideal hedge plant should be—

(1) Perfectly hardy.
(2) Capable of rapid and easy propagation.
(3) Fibrous rooted and therefore easy of transplantation.
(4) Evergreen.
(5) Compact in habit.
(6) Rapid in growth.
(7) Drought-resistant.
(8) Responsive to trimming, and
(9) Sufficiently soft in growth to permit of easy cutting by hedge-shears.

I have not observed any plant which positively has all the qualities enumerated above. The popular Lime, Duranta or Dodonœa most nearly approach the ideal. "Jait" (*Sesbania*), Bougainvillœa, *Acacia farnesiana*, are not so good, though each excels in some way for special purposes.

I will briefly consider the more important of the above mentioned.

Duranta plumieri with blue flowers and its white variety are together the most popular hedge plants in the Punjab. Though browned a little during the cold days of January, they are yet evergreen and thoroughly hardy over the greater part of the Province. Cuttings planted in March, in a sheltered nursery, root almost as readily as willows and are fit for transplanting to their permanent quarters by the following August. Seeds germinate freely in spring, but the growth of seedlings is comparatively slow. Being fast in growth, the shoots soft and easily trimmed, and the plant branching freely, a compact, firm hedge can be quickly formed.

But the Duranta is only a moderate drought resistant ; the burning days of May and June leave the hedgerow limp and dusty. On the other hand, the plants revive with remarkable rapidity after rain or irrigation.

The foliage of the Duranta is somewhat rough and retains dust. On this account, the plant is not suitable for planting by much trafficked public roads. Nor is a solid firm hedge of over

four feet in height readily formed by Duranta. Lime is then more stable and satisfactory. When a free untrimmed hedge is desired, the Duranta can hardly be excelled. Both the blue and the white, but more especially the white, varieties make exquisite pictures when drooping in their lavish profusion of charming blossoms and orange-coloured berries. Then the dainty sprays, so suitable for vases, can be gathered during quite eight months of the year.

Though the white is only a variety of the blue *Duranta plumieri*, the former differs most decidedly from the species in several important points. The white variety has deeper green and tougher foliage, a more compact habit, and it is less readily affected by drought. For hedges of $2\frac{1}{2}$ feet and under, the white variety is the better plant.

Dodonæa viscosa—The "Sanatta" or "Aliar" almost rivals the Duranta in public favour. It also is scorched just a little during the more severe days of January in some years. But it is hardy, thoroughly hardy, in any part of the Punjab plains.

In a plant so very easily and quickly raised from seeds, there is no necessity for propagating by cuttings. If seeds are sown broadcast, in the poorest of soil, in February or March, the plantlets will be fit to transplant, 9 to 12 inches apart in their hedge-row lines by August. If planting has been done with care, a beautiful compact bright green hedge of 2 to 3 feet in height should result by the 15th October of the same year. Within 18 months from the date of seed sowing, a well-managed Dodonœa hedge should be 3 or 4 feet in height, solid, trim, of a beautiful shining green and quite as fine as the best 5-year old "Privet" hedge in England. Surely, this is rapid enough for the most impatient of gardeners.

Dodonœa seeds are frequently sown where the hedge is desired. This method is not generally satisfactory: a close, uniform hedge is rarely obtained by this method. Besides, growth is much more rapid when the plants have been transplanted.

Setting out plants which are over 6 months of age is another frequent cause of disappointment, as the Dodonœa is impatient of disturbance when over the above age.

Nor does the Dodonœa carry well by rail, however carefully packed, for plants should be in position within 2 or 3 hours of their actual lifting. Duranta or Lime plants may hang their heads after transplanting for a few days; yet all may be well. Not so with the Dodonœa. If two days after planting, any plant curls its foliage, replace it—it will die. The Duranta is fibrous-rooted; the Dodonœa is tap-rooted. It will be understood, therefore, why the Dodonœa must not be transplanted after it is six months old; its tap root will have rooted deeply, and in lifting, this would be severed.

The Dodonœa is at home on the arid slopes of the Sivaliks and of the Salt range, and, as is to be expected, is an admirable drought-resistant. In a good sandy loam with sparing irrigation, it is luxuriant. In a wet sour soil, the Dodonœa simply will not grow.

As to trimming, no hedge plant is more easily clipped. The *mali* delights in trimming Dodonœa. A word of warning is necessary, however. If trimming is neglected for even three months between April and October, the hedge may be irreparably spoiled. A Dodonœa hedge may be maintained practically at 3 or 4 feet in height for five or more years, but it cannot be headed back. Lime or Duranta, on the other hand, springs with renewed vigour when severely pruned.

Thus far only the praises of Dodonœa have been sounded. Now we come to some grave defects. Our subject lacks firmness and stability; a child may brush through the finest and most compact Dodonœa hedge. Happily, however, displaced twigs and branchlets as readily assume their former positions. Next, and this is a most serious fault, many Dodonœa plants die during an exceptionally wet monsoon such as we last year experienced. In normal seasons, however, the plants are not injuriously affected. Duranta and Dodonœa plants cost from Rs. 4 to Rs. 6 per hundred.

Citrus medica—In the "Lime," we have a hedge subject totally different from the Duranta and Dodonœa.

In considering the Lime, it must be borne in mind that there are two distinct varieties which are commonly planted. The best, and that which is most frequently used for high, bold hedges, is known as the "Khatta Nimbu" or large sour lime. This variety has much broader foliage, and more lusty growth than the small sour lime or "Khatti Nimbu." The latter is used for hedges which are under five feet in height. Both varieties are perfectly hardy, even well up on the hills, both are evergreen, fairly rapid in growth, and form handsome impregnable hedgerows when well-grown.

Limes may be planted in the form of hedgerows until they are six years of age and quite five or six feet in height, provided the plants have been transplanted two or three times during that period.

The plants are raised from seeds, and these germinate most freely when sown broadcast in late November or December, in sheltered and well-prepared nursery beds, or in 8-inches pots. Lime seeds soon lose their vitality and must be sown immediately they are extracted from the fruits.

The seedlings are not generally large enough to transplant to the nursery lines within less than six months from the sowing date, and during the rains is the best time to perform the work. Sturdy plants, of about 18 inches in height, should be ready for their transfer to the hedgerows within 18 months or 2 years from the date of seed sowing.

It will thus be seen that the amateur gardener will save much time by purchasing nice plants either in early August or late February. The cost of plants is about Rs. 10 per hundred, and is, therefore, double that of Duranta or Dodonœa.

Probably because of the rather high price of plants, limes are frequently planted at over wide intervals. This is to be regretted. When more than 18 inches are allowed between the plants, a well-furnished hedge is not readily made unless very hard cutting-back is carried out during the first two years of growth

The shoots of the lime are somewhat tough and certainly are not so easily cut as those of Duranta and Dodonœa. Trimmed at the proper time, however, cutting is not at all difficult.

I have known the roots of a lime hedge to be submerged in water for ten days, and apparently without any after-ill-effects to the plants. On the other hand, I have observed a lime hedge to appear to be utterly dried up in May and June; yet in mid-August and during the rains, the same was lush, green and happy.

It is unfortunate that the lime cannot be more rapidly propagated, and that the cost of the plant must always be rather high on that account. Rs. 10 per hundred plants with heavy freight charges added, make hedge planting decidedly costly.

The *mali* complains that lime hedge cutting is hard work, but his complaint is true only when trimming has been unduly delayed, and the growths have toughened. Under the care of sturdy workmen I believe that the lime would prove almost the equal of the justly lauded holly or yew of England in all-round excellence as a hedge plant.

The Duranta, the Dodonœa and the Lime, I believe, exhaust the list of really efficient and popular Punjab Garden Hedgerow subjects. Others there are which are superior under special circumstances. *Sesbania ægyptiaca,* the "Jait" of the *mali,* for instance, is unequalled by any hedging plant in rapidity of growth. Seeds sown *in situ* in early March will give a dense hedge of from 6 to 10 feet in height by the following October. The foliage too is pleasing; it is almost an ever-green; the habit of the plant is erect and compact, and altogether, by the end of the first season, the "hedge-at-once" problem would appear to be solved. In the second year, however, and especially after trimming, a "Jait" hedge presents a somewhat bare and rather sorry appearance, and it will not then compare with the slower growing Dodonœa. With each succeeding year "Jait" becomes more unsatisfactory, but as a rapid growing temporary screen "Jait" is not excelled.

Acacia farnesiana, the "Vilayati Kikar," is not a true garden hedge plant, being over-rampant in growth and more

suitable for the forming of big boundary hedges. In the more Northern parts of the Punjab, where this "Kikar" is very popular, the erect rampant shoots are not entirely removed when trimming is done, but are cut half through at a uniform height and horizontally heeled over throughout the length of the hedgerow. In this way, a dense thorny impregnable fence is soon formed. The small globose fragrant orange yellow blossoms are profusely borne in late Autumn.

Plantlets may be transplanted from nursery beds at 2 feet apart in the line of fence, or seeds may be sown *in situ* and duly thinned as the plants gain in size. Hedges are frequently desired for the crests of banks or by roads or paths which are considerably above irrigation level. For such position, the scandent or trailing *Clerodendron inerme* is superior to Dodonœa, Duranta or Lime.

This *Clerodendron* is rampantly vigorous; the foliage is of a deep glossy pleasing green; the plant is even more drought-resistant than Dodonœa; and trimming is most easy.

Set the plants out at 4 feet apart in March; run a stout wire as rail at about two feet above the line of the plants; lightly trail the growths as they develop over the strained wire or the rail; trim that face of the hedge which is towards the road; and let the shoots freely ramble over the bank behind.

In the course of one season, a *Clerodendron* hedge so treated should present a perfect smooth face of 2 feet in height on the desired side, whilst the dry bank or unsightly channel behind would be effectually screened with the trailing shoots of deepest green. Propagation is readily effected by cuttings during February and March. Plants cost Rs. 12 per hundred, and if these are set out at intervals of 4 feet, it will be found that the *Clerodendron* is one of the very cheapest hedging subjects for positions such as I have mentioned.

Where space is not restricted, the handsome Bougainvillœa forms a very beautiful free boundary or screen. It is ever-green; it glows with bright colour during the cold season; it is perfectly hardy in any part of the Punjab; it is almost grossly vigorous,

and when established, it is independent of any artificial irrigation whatever.

Though trimming presents no difficulties, it must be carried out with discretion. It is necessary to thin the growths; not merely to shorten these.

The Bougainvillœa is not so easily propagated as most hedging subjects. Stout cuttings are generally procurable, and these, if inserted at about 6 × 12 inches apart in sheltered nursery quarters during March or August, should give a very fair percentage of plants fit for setting out twelve months later.

Some roses, certain climbers, a few shrubs such as *Lawsonia alba*, "Mehndi," *Nerium oleander*, etc., are occasionally used with fine effect as fence plants, but these do not form true hedgerows and will not be considered now.

I will conclude by a few comments on the planting and care of hedges.

It is the custom of the Punjab *mali* to dig a small pit or hole for each plant to be set out in the hedgerow. This method is the worst possible. On no account permit the *mali* to have his way in this, but insist that he takes out a good clean trench at least 18 inches wide by 2 feet in depth. It is impossible to correctly space big and little plants when pits are made; it is too much to expect plants to grow freely into unbroken soil.

If it can be allowed, let the trench remain open for a week and in the meantime, mix some mellow manure with the soil thrown out from the trench. A Lime hedge specially appreciates enriched soil.

After filling in the soil in order to bring the plants to be planted to the required level, twelve or more plants should be set out in the trench at the required distance apart and simply steadied by a little soil. When it is seen that all the plants are straight, and that big and little duly alternate, rapidly fill in the soil, taking great care that this is firmly, yet gently, rammed around each plant. No plant should have more than one inch of soil over its nursery soil line.

The filling in of gaps in an established hedge is difficult and is seldom successfully accomplished. The more forward neighbours of any plants inserted monopolise the soil moisture and nutriment, and the young plants gradually succumb if not specially nourished. If the eriginal work of planting is thoroughly carried out, there should be few failures in the hedgerow.

For irrigational purposes, a depression of not more than 3 inches in the line of the hedge is ample.

Hedging is frequently planted in deep ditches which are at the same time utilised as the channels for the irrigation of the other parts of the garden. So far as possible, this should be avoided as harmful to the hedges.

On the completion of planting, give the hedge a most thorough "flooding home," and this may be repeated a week later.

Not till the hedge plants have been established some three months, and growth has vigorously started, should any pruning be done; and this at first should be confined to lightly shortening the rampant shoots. All that is at first necessary is to preserve a balance of growth in the plants. A Duranta hedge planted in February would require its first real trimming into shape in early August. Later, the trimming must be regularly attended to as often as the top growths gain a length of six inches.

A Lime hedge requires much more severe cutting for its first real shaping in August. The object is to ensure a sound foundation of stout branches. A Lime hedge should be brought on slowly for two years. In the bare open bases of many Lime hedges, there is evidence of undue initial haste.

The Dodonœa merely requires the removal of a few straggling shoots during its first few months of growth, after which regular clipping may be taken in hand.

Undoubtedly trimming to the wedge shape produces the finest hedge. This method is not generally adopted by the *malis*. The square clipped form is favoured. The *mali* finds it so much easier trimming below than on top. He clips more and more beneath and more and more neglects the upper part, until the hedge reels with its top weight and becomes unshapely.

Most fortunately insect pests have thus far not seriously troubled hedge plants in the Punjab.

But there is one dread parasitic plant which is a host of evil in itself, and which is ruining countless hedgerows and trees throughout the Punjab—the insidious *Cuscuta reflexa*. This parasitic convolvulaceous climber stealthily spreads its web of orange yellow threads with marvellous rapidity throughout the body of any hedgerow on which it may have gained its foothold and sucks and strangles its victims to death in a very short time. The first sight of it on the hedge of the keen gardener fills him with despair. He knows he has months—perhaps years—of patient watching and removal of the "threads" by hand to do if he is to conquer the almost irrepressible foe. There are no remedial measures other than the persistent removal of each thread when seen. Where the parasite has permeated the body of a hedge, there is absolutely no hope of eradication. The hedge must be cut to within six inches of the ground ; the surface soil removed from beneath the plants ; and fresh young growths taken up. Even with such drastic treatment, the hedge must be most carefully watched during the succeeding 12 months.

This *Cuscuta* is reproduced by seeds which may germinate either directly on the host plant, or on vegetable soil beneath the host. The yellow thread-like growths can also reattach themselves to any suitable host. It will, therefore, be seen how necessary it is to be most thorough in any repressive measures. Every twig of any hedge cut down and even the soil from beneath such a hedge should be burnt.

Good roads, smooth green lawns with some nice specimen trees and shrubs, form the most constantly pleasing features in the gardens of the more Northern Provinces of India. Well-chosen, bright, trimmed, and suitably placed hedges can be grown with facility and lend the further charm of privacy and completeness.

OIL ENGINE AND PUMP IN THE TELINKHERI GARDENS AT NAGPUR.

SOME CRITICISMS.

In the last October number of the *Agricultural Journal of India* a note on the working of the oil engine and pump in the Telinkheri Gardens at Nagpur was published. The information was supplied by the Director of Agriculture, Central Provinces. The note has attracted some attention, and Mr. Alfred Chatterton, Director of Industries, Madras, has sent us the following remarks :—

"In the October number of your Journal is a note on an oil engine and pump in the Telinkheri Gardens at Nagpur at the end of which the remark occurs: 'Still it should be stated that oil engines can only be economically used where the supply of water is sufficient to keep them working for 10 hours a day.' I do not know whether that statement is a deduction from the results obtained in the Telinkheri Gardens, or whether it is based on additional independent data. In any case I do not think it should be allowed to pass without comment, as it is very far from the truth, when the engines and pumps are put down by an Engineer and are properly suited to the work that is to be done. In the Madras Presidency there are over 150 oil engines and pumps now at work, and many of these do not work more than six hours a day, and yet they yield highly satisfactory results, and with oil engines and pumps which get 10 hours' full work a day the cost of lifting the water is just one-fourth of what it is with a mhote.

2. "The oil engine and pump in the Telinkheri Gardens are an example of bad work, and the data afforded only serve to demonstrate that fact. Taking the data given in the note, 6,480

gallons per hour were raised to a height of 19 feet, which is equivalent to 0·623 horse-power in the water delivered : that is to say, the efficiency of the engine and pump was 12·46 per cent. I should be glad to supply data of an almost similar installation in which a $3\frac{1}{2}$ h.-p. engine drives a 3″ pump and delivers 13,000 gallons of water per hour to a height of over 25 feet, with an efficiency of nearly 50 per cent.

3. "The Telinkheri installation is defective in the following respects : A 2″ centrifugal pump is a very inefficient motor and should never be used for irrigation work. The smallest size of centrifugal pump which can be suitably employed is a 3″ pump delivering about 11,000 gallons of water per hour. Not only is the 2″ pump too small for the work, but it is obviously being overdriven. The average discharge is stated to be 6,480 gallons per hour, which is at least 33 per cent. more than the pump is designed for, as the velocity of water through suction pipes is 16 feet a second, and the frictional head against which it must work is, therefore, very considerable. If the speed of the pump were reduced so that the pump delivered about 4,500 gallons per hour, a 2 or $2\frac{1}{2}$ h.-p. engine would easily drive it, but it would be much cheaper to substitute a 3″ pump which, driven at its proper speed, could be easily worked with a 5 h.-p. engine running for about two hours in the morning and one and-a-half hours in the afternoon. This, of course, in this particular instance, would not affect the cost of working very much, as it would only mean that the cost of the kerosine oil would be less. That, however, would decrease by Rs. 1-4-0 a day, and the number of gallons lifted for one anna would be 733 or slightly more than the figures given for the mhote. It would thus appear that with the small supply of water available and using kerosine oil, an engine and pump could be made to do the work as cheaply in the Telinkheri Gardens as if it were done by a mhote.

4. "I should like to raise a mild protest against the comparison of daily expenses in a case like this, as the period is too short, and it would be fairer to take the annual working expenses. If an engine and pump are not at work, the interest charges

alone have to be met, as the driver can probably be employed on the other work. During wet weather when the mhote is not required, the cattle have to be fed. Moreover, cattle, working a mhote, require at intervals a day's rest, or they get out of condition.

5. "The deduction I should like to draw from your note on this installation is that it represents the extreme case in which pumps can be employed. The determining factor as to the economy of employing oil engines and pumps for lifting water is not the number of hours per day during which they work, but the quantity of water which has to be lifted, and this, from experience in the Madras Presidency, I put at about 40,000 gallons per day, which means that an engine and pump will then get between three and four hours' work. With double that supply, or seven hours' work a day, the economy is very considerable.

6. "During 1908, in the Madras Presidency, the Department of Industries has erected about 60 installations of oil engines and pumps for private owners, and a considerable staff of Upper Subordinates has been employed in investigating schemes. We never put down a centrifugal pump with a suction pipe of less than 3″ diameter, and we never advise the purchaser of an engine and pump to instal a plant unless there is a certain water-supply for the greater part of the year, of 60,000 gallons per day. From experience we know fairly accurately the power taken by any size of pump on a given lift, and to that we add 33 per cent. to determine the nominal brake horse-power of the engine to be purchased. I say nominal brake horse-power as few oil engines and pumps will develop the brake horse-power they are rated at by the makers without giving trouble and requiring frequent repair. Where the lift varies greatly, we provide two pulleys on the pump, so that its speed may be changed when necessary and overdriving prevented. Guided by these simple rules, irrigation with oil engines and pumps is rapidly spreading and will ultimately become an important factor in the agricultural development of India. It is desirable, therefore, that

accurate information regarding its possibilities should alone be disseminated."

The Executive Engineer of Raipur has also made the following remarks on the same note :—

"I have read with interest your article in the October issue of the Journal on the results of pumping with a centrifugal pump driven by an oil engine at Telinkheri Gardens at Nagpur.

"May I be permitted to challenge your statement that an oil engine and centrifugal pump cannot be economically used unless pumping is required to be done for 10 hours a day?

"Perhaps, my own experience may be of interest to your readers. I have worked in my compound for garden irrigation, a Ruston and Proctor 6 B.H.P. Oil Engine, driving a Mark 3 Ruston and Proctor Centrifugal Pump. The pump has a 4″ suction pipe and 3″ delivery, and the present lift is 19′, the same as that of the pump at Telinkheri.

"The plant is guaranteed to deliver 200 gallons per minute against a total lift of 35′.

"By actual test I find the pump delivers on the present lift 200 gallons per minute with a consumption of oil, per hour, of 0·467 gallons.

"The oil used is Standard Oil Co.'s 125 test kerosine oil, costing Rs. 2-3 per 4 gallons at Raipur, including cost of the tin. The cost of oil per hour is, therefore, annas four.

"At 200 gallons per minute it would take the pump 3·24 hours to raise the 38,880 gallons which the Telinkheri plant raises in six hours. The kerosine oil consumed in doing this work would cost As. 13-3.

"Besides the oil used in the engine, three-eighths pint of 150 test Tide-Water Oil Co.'s Snow flake Oil is required for the starting lamp each time the engine is started.

"This oil costs Rs. 3 per 4 gallons.

"To start the engine twice daily would, therefore, cost As. 1-3. The plant cost Rs. 2,000 landed at Raipur.

"Taking the cost of lubricating oil, wages of Engineer and cooly, the same as at Nagpur, the total cost of running the

engine and pump to raise 38,880 gallons daily, starting and stopping twice in each day would be—

	Rs.	A.	P.
Kerosine oil for engine	0	13	3
Kerosine oil for starting lamp	0	1	3
Wages of Engineer	0	8	0
Wages of Cooly	0	4	0
Lubricating oil	0	4	0
	1	14	6
Depreciation on Rs. 2,000 @ 10% per annum	0	8	9
Interest on Rs. 2,000 @ 4% per annum	0	3	6
	2	10	9

which gives an output of 909 gallons per anna as against the 720 per anna when bullocks and mhote are used.

"It is evident, therefore, from these figures that even when so small a quantity of water has to be raised, an oil engine and centrifugal pump will do it cheaper than a mhote and bullocks. I do not know why the experiment has resulted so badly at Nagpur; possibly the small size of the pump has something to do with it; but even so, it would appear that a mistake has crept into the calculation of the oil consumption."

Copies of the above two letters were sent to the Director of Agriculture, Central Provinces. He gives the following note by Mr. D. Clouston, Deputy Director of Agriculture :—

"The note in the *Agricultural Journal* on the working of the oil engine and pump at Telinkheri was taken from a report which was asked for by the Inspector-General of Agriculture. The report is an accurate statement of the results obtained in working this particular installation under an officer of the Public Works Department. In the report it is clearly stated (1) that the engine was too strong for the pump and that there was, therefore, a waste of power, (2) that the cost of working could be reduced by using liquid fuel instead of the more expensive kerosine, and (3) by dispensing with the service of a whole-time cooly.

"I was dissatisfied with the working of the installation, the cost of which was, I considered, excessive.

"The estimate submitted by the Engineer in charge was as follows :—

Total cost of working per day of 8 hours.		Quantity of water raised in gallons per hour.	REMARKS.
Daily.	Rs. A. P.		
Anchor Brand Oil	4 7 0	Maximum delivery per hour with valve full open, 4,800 gallons.	This engine is larger than is required by the pump, so the upkeep is more than would be necessary if the pump and engine had been properly proportioned.
Castor Oil, ½ bottle...	0 4 0		
Cocoa Oil for cylinder, ½ bottle...	0 4 0		
Cotton waste, 1 lb.	0 3 0		
Miscellaneous, soap, etc.	0 2 0		
Total ...	5 4 0		

Driver on Rs. 15 p.m., As. 8 per diem.
Cooly on ,, 10 p.m., ,, 5 ,, ,,

Total Rs. 6-1-0 per day.

(Sd.) ALFRED E. JOYCE,
Asst. Engineer in charge,
P. W. D. Workshop.

"On taking over the installation I got certain economies introduced which reduced the total cost of working to Rs. 3-14-0 per day of six hours when kerosine was used.

"One fact is that in this case a mistake was made in ordering a pump that was too small for the engine.

"In paras. 2 and 3 of Mr. Chatterton's letter great stress is laid on this point, and Mr. Chatterton states that nothing less than a 3″ centrifugal should have been used. But I find from correspondence between him and my department that he recommended for this well, a 2″ centrifugal pump driven by a 5 b.h.-p. or a 3″ pump driven by a 7 b.h.-p.

"In para. 3 Mr. Chatterton admits that under the circumstances described a 5 h.-p. engine and a 3″ centrifugal pump would not be fully employed, and that an ordinary mhote would approximately lift as much water in a working day. In the case of the oil engine much time and money might be wasted if even a small piece of machinery got out of order as no local arrangements exist for repairs.

"Regarding para. 4, I should like to point out that the figures given by me for the cost of working a mhote applied to

the conditions which exist in these Provinces. The bullocks that work in the mhote during the dry weather are kept fully at work in rice cultivation during the rains, so that at no season are they idle as Mr. Chatterton would seem to suppose. As regards cattle requiring a day's rest now and then when worked in the mhote while the engine driver is supposed to work continuously, this also is a mistaken idea. My experience is that bullocks can be worked continuously in the mhote for six hours per day, *i.e.*, (the time on which my calculation was based) if allowed to move at a slow pace all the time—the pace required to raise 56 mhotes per hour from a depth of about 25 feet.

"The engine driver, on the other hand, is a much less dependable asset, and does take a day off now and then.

"I am rather of the opinion that at present there is no place for oil engine and pumps in these Provinces. For lifts exceeding 20 feet the mhote does the work cheaply and well; for depths of less than 20 feet the chain pump driven by a gear will lift water more cheaply than Mr. Chatterton's most efficient installation.

"It may be that in future workshops will be started where repairs can be done and where boys can be trained in engine driving; but at present such mechanics are not available, so that if this method of lifting water were adopted, the cost of repairs would be excessive. Moreover, the initial cost would deter cultivators from such an investment."

The Director of Agriculture, Central Provinces, sends the following remarks :—

"I agree with Mr. Chatterton that this is a bad example of such installations: but his criticism appears to me to be unjust, for it was on his advice that an engine too large for the pump was installed. At the same time it is impossible for me to reconcile the figures of actual cost of working with those given by the Executive Engineer, Raipur.

"On the general question, my opinion with that of Mr. Clouston agrees fully.

"An installation of this type would, no doubt, pay if owned by a man who actually understands machinery, and can do his own petty repairs. A tenant cannot afford to pay a highly skilled mechanic : and moreover, he is too remote, as a rule, from skilled advice to supervise and control his man's work ; for any trifling repair a mechanic must be conveyed to the engine and paid his fee, and small sums under these heads will produce a big total at the end of the year. On the other hand, any local *mistri* can make or mend a chain pump. At the present time I do not think that these installations can be introduced in the Provinces for agricultural purposes."

THE INTRODUCTION OF DRILL-SOWING AND INTERCULTIVATION ON TO THE BLACK COTTON SOILS OF TINNEVELLY, MADRAS PRESIDENCY.

By H. C. SAMPSON, B.Sc.,

Deputy Director of Agriculture, Madras.

In 1907-8, the Government of Madras gave an allotment of Rs. 5,000 for the improvement of cotton cultivation, and it was decided that a part of this sum should be utilised in introducing the practice of drill cultivation for cotton into the Tinnevelly District.

To some extent, the way had been prepared. This method of cultivation had been introduced on to the Koilpatty Agricultural Station, and in the 1906-7 season, after this station had been enlarged, there were 51·35 acres of cotton, all sown with the drill. The crops which were much superior to those outside the farm began to attract attention in the neighbourhood. In March 1907, when the cotton-picking was at its height, Mr. Couchman, Director of Agriculture, and Mr. Wood, Deputy Director of Agriculture, who then had charge of this division, when inspecting this station, assembled the neighbouring *ryots*. The methods of cultivation were explained to them, the farm crops were compared with those outside, and the implements were shown at work and even handled by the *ryots*. Several of them there and then promised to try this method of cultivation if assistance were given them. The very roughness in the workmanship of the implements pleased them, as such work could easily be turned out by their own carpenters and blacksmiths. But a promise given when the crop is ripe for picking is a very different thing to its

PLATE XX.

A. J. I.

I. Broadcasted and Drill-sown Field, with Owner, at Pallikkottai.

fulfilment at the next sowing time, and there were many obstacles to be overcome before such a revolutionary change in the methods of cultivation could be brought about. A brief description, therefore, of the people and the local conditions, and the method of cultivation which it was wished to introduce, seems necessary. The black cotton soil cultivators of this district are both Telugus, who, it is said, came south during the time of the Vizianagar and Naick dynasties and settled in the district, and Tamils. The Telugu is noted throughout the Presidency for his love of the black cotton soil and throughout the whole of the Tamil country, Telugu villages are to be found wherever there is any extent of black cotton soil.

In two of the three Taluks which adjoin the Koilpatty Agricultural Station, *viz.*, Ottapidarum and Satur, the vernacular of one-fifth and one-third, respectively, of the total inhabitants is Telugu, and when one bears in mind that this race is almost entirely confined to the black soil areas, the proportion who cultivate cotton must be much greater. The chief Tamil castes are the Vellalas, Pallars, Maravars and Shanars. The first two are both good cultivating castes. The Maravars also cultivate, but depend also on dacoity and cattle-lifting and are, therefore, not so thrifty. The Shanars are the toddy-drawing caste and are excellent petty cultivators, growing irrigated garden and cereal crops under wells. Thus, the introduction of any improvement has to be repeated in almost every village, for it by no means follows that if one village adopts an improvement, the next village, if of a different caste, will follow its example. And besides the natural conservatism of the *ryot*, superstition and fear of offending the deities have also to be overcome. As an example of this : in November 1907 a very heavy rain of more than 7 inches fell on one day and breached several tanks, besides doing considerable damage to the standing crops on the black soil. As a result, some *ryots* refused to work the bullock-hoes in their drill-sown crops, as they said that this rain was a signal of divine wrath. One man actually ploughed up his crop.

The present agricultural practice on the black soil was dealt with in detail in the Scientific Report of the Koilpatty

Agricultural Station, 1907-8. From this it will be seen that the Tinnevelly black soil *ryot* is an excellent cultivator. Suffice it to say here that instead of sowing cotton broadcast, covering with the plough and doing the after-cultivation with hand-hoes, we wished to introduce the practice of sowing in rows with the bamboo seed-drill, covering the seed with the blade cultivator and doing the after-cultivation with the small blade bullock-hoes. All these implements, though common in the Northern Districts and in other parts of India, are unknown in the south of Madras.

When it was decided to take steps to introduce this system of cultivation, there were only two coolies in the district who knew how to work these implements, and these were only local men who had been trained on the Koilpatty Agricultural Station and who only knew that particular class of soil. Therefore, it was decided to bring down men who had been used, all their lives, to these implements from the Bellary District. Accordingly, some 26 sets of implements were made during the hot weather months, ready to be lent out to *ryots*, and six Bellary men were sent down at the beginning of September (six weeks before the sowing season). Five of these only reached their destination; one being afraid to go so far from his native country, left the train at the next station after its departure and went back home. These men were purposely brought down early in the season, so that they could become accustomed to the South Country bullocks and could train the other coolies, employed in the Agricultural Station. It proved afterwards that it was well that this precaution had been taken, for these men were, with one exception, only of use in training the local farm coolies under the supervision of the farm staff. They proved to be just as conservative, in their own way, as the *ryots*, whom they had been intended to teach. They were unable to handle or drive the bullocks which were unused to the noises made by them when driving. In fact, several *ryots* refused to let these men continue working, as they could not drive a straight furrow and preferred the newly trained local coolie who was used to their local cattle.

PLATE XXI.

A. J. I.

II. Broadcasted and Drill-sown Field, with Owner, at Pallikkottai.

This was not the only objection to these Bellary men. They knew no Tamil, and their language was a mixture of Telugu and Canarese, so that they could only make themselves understood in the Telugu villages. Also their different customs and unthrifty habits at once prejudiced the Tinnevelly *ryot* against them.

During the first year of the introduction of these implements, the Manager of the Agricultural Station selected the adjoining Telugu village in which to concentrate his efforts. The selection was a good one. The Telugu, who is comparatively a recent arrival in the district, is not so bound down to custom as the aboriginal Tamil, and it is easier to get him to try improved methods. The village mainly depended on its black soil which was, on the whole, excellently farmed land. Some sixty acres were sown with the drill last season and some excellent crops obtained. In one or two other neighbouring Tamil villages, small areas of four or five acres were sown. In one case, the owner of the land quarrelled with the whole of the rest of the village for introducing something new, but they were appeased when they saw his crop, and this season in the same village more than seventy acres have been sown with the drill. In the first year, about 200 acres were sown on *ryots'* fields with the drill.

In the year 1908-9, a similar allotment was made for cotton improvement, and it was decided to continue this work as well as to introduce seed-farms for growing pure Karangani cotton of the strain selected on the Koilpatty Agricultural Station. This gave an opportunity of spreading this system of cultivation further afield than Koilpatty, but was a much more difficult matter to arrange, as in many parts of the district, the Department was unknown, and the Agricultural Station at Koilpatty had not been heard of.

In order to cope with this work as well as the extension, probably on the success of the previous years' operations, several new hands had to be trained. This meant a very careful selection on the part of the Manager at Koilpatty, and many of the would-be sowing experts had to be got rid of after a trial. Besides this, the Manager had to bear in mind the villages in

which the extension would probably take place and to train either a man of that village or a man of similar caste. The best men, it was found, were petty *ryots* who owned land in the village where they were to work. They, as a matter of course, looked after their own interest and sowed their own lands first. This new introduction naturally attracted much attention in the village and gave others confidence in the practice. When the sowing season commenced, there were some 22 trained coolies available. Their training was by no means complete, as they had only been taught to sow in dry land, at first with coarse sand, and afterwards with boiled cotton seed. Thus, they had never seen any crops which had come up with their sowing and had never sown in a moist seed-bed. It was necessary, therefore, for one of the staff to be present at the commencement to see that the work was started properly.

The seed-farms were, however, the main outside centres of the introduction of this improvement. Five centres had been selected in different parts of the district, and to each of these trained coolies were sent with a set of implements. My Assistant, M. R. Ry. J. Chelvaranga Raju, had charge of this work and made the necessary arrangements with the owners of the land. The terms on which this was obtained were as follows :—The land selected should not have grown cotton the previous season and would be required for one season only. The Government should pay the assessment, provide the seed, sow it with the drill and do the subsequent bullock-hoeing when necessary. The *ryot* was to do the primary cultivation, was to pen the land with sheep and was to do any hand-weeding, was to thinly crop as directed and was to sell to the Department the main season *Kappas*, well-dried, at Rs. 4 per candy of 500 lbs. above the market price. It was interesting to follow each of these seed-farms, as each was worked under different conditions. The most satisfactory was at Pallikkottai, a Vellala village, where thirty acres of cotton were grown for us. The land belonged to several owners in the village, each contributing three or four acres. No man in the village owned or rather farmed more than 15 acres, and most of

PLATE XXII.

A. J. I. Showing on the left the Drill-sown Crop; on the right, a Broadcasted Crop sown on the same day.

them had to depend on this for a living. Thus, we had excellently farmed land to deal with. At first the *ryot* thought that he was risking a great deal, having never seen anything but his own cultivation before, but afterwards, when he saw the germination and subsequent growth, he looked after his share of the cultivation to the best of his ability. We were ingeniously told when inspecting this area that next year we could have our pick of the best lands in the village if we wished to grow cotton again, implying that this year they had given us anything but their best land. This village had already ordered two shares of implements to be made for them in Tinnevelly. Plates XX and XXI show a broadcasted and drill-sown field in this village with their respective owners. It is unfortunate that the light and shade in the two pictures are not the same. The trained coolie who looked to the sowing of the seed-farm had also to sow land, for people wished to try drill cultivation on their own account, but this was confined to another village some ten miles away, as the people of Pallikkottai thought at the sowing time that they were already risking enough in growing seed for us. Though 30 acres of seed-farm are allowed for each trained coolie to manage, if we had not been particular about getting the seed sown in good time, he could have sown a larger area. Therefore, this demonstration work was also added, as it was thought that a man of this class would be spoilt if he were allowed to idle his time. In the village where the demonstration blocks were, some inducement was necessary to get people to try this. My Assistant offered to sow an area of 3 acres of land with two pairs of bullocks at the same time that one of the *ryots* who had just commenced sowing broadcast in the next field of similar area would with seven pairs. This offer decided the owner, and the work was completed in both fields at the same time. I saw the crops on inspection two months after sowing. No rain had fallen since sowing till a few days before. In the broadcasted field, there were a few stray plants, and the other seeds were just germinating. In the drill-sown field, there was an excellent stand.

In the next seed-farm at Maniyachi, it was only with the Tahsildar's influence that people unwillingly consented to grow seed for us; 20 acres belonging to three owners were sown and naturally they gave their worst fields for the purpose. Cattle could only be hired to work the implements through the influence of the village headman. Sowing was, however, completed on November 11th, having been delayed by previous incessant rain, and no more rain fell till the end of January. Plate XXII shows on the left hand side the drill-sown crop, and on the right a broadcasted crop belonging to the same *ryot* and sown on the same day. The latter had just germinated, but the plants are too small to show in the photograph which was taken on January 11th. Here, again, the owners wished that they had given better land and are anxious for us to sow again next year on a more extensive scale. The third seed-farm at Mullakulam belongs to a retired Government official, who, until now, has leased out the land on a yearly lease. The land here is poor and very shallow, and, as a result of the system of lease, very foul with weeds, but this year we had to be content with what land we could get. Here one of the objections to locally trained coolies was met with. The man had been used to sowing on the fairly deep soil of Koilpatty, and coming here he sowed at the same depth. Heavy rain soon waterlogged this shallow soil, and germination was spoilt. One of the owner's own servants, an excellent Telugu cultivator, was trained locally to assist this coolie sent from Koilpatty, and he, knowing the land evidently, sowed accordingly, as his sowings gave an excellent stand. The owner has done everything to assist with his share of the work and has now got the land fairly clean, so that next year his labour will not be lost. Demonstration plots in the neighbouring village of Telugu cultivators have given excellent crops, one of the best that I saw in the course of my last inspection.

The fourth seed-farm of 30 acres is at Nainapuram. Here the owner is a rich man, and with the help of his son and an agent, attends to the cultivation himself. This has not been inspected by me as yet, but evidently the crop has proved

satisfactory, as the owner has already ordered a set of implements to be made for him for next season. The fifth seed-farm is at Ettayapuram on one of the zamindar's Home Farm lands. This is 100 acres and the largest of all, but here work is not so easy as it is when the land belongs to smaller *ryots*. The land is not so well cared for, and all the work has to be done through the managers of the several Home Farm lands, while the Home Farm coolie establishment naturally follow the lead of their master. This much depends on whether the manager happens to favour the work. This seed-farm is doing well, and the *ryots* of the village say that this land has never borne such a good crop, but, at the same time, it shows a striking difference to a 20 acres block which the zamindar's uncle has grown for seed for us. The owner attends to all the details of his cultivation himself and has sown our seed with the drill, but though quite willing to grow seed for the Department, does not care to accept even the assessment. This gentleman frequently visits the Koilpatty Agricultural Station and takes a keen practical interest in what he sees there. He has also had a set of implements made locally for his own future use. His crop was the best I have seen this year.

As these seed-farms were in a way the forerunners of the extension of drill cultivation, the very best of the trained coolies were sent to these. A mistake, however, was made in one or two cases in not making proper arrangements for the welfare of these men. All of them were Pariahs or low caste men, and consequently in some cases they had rather a rough time of it. The sowing season is the commencement of the rains, and there is a great fall in the night temperature after rain. In consequence, several of the coolies fell sick with fever and had to be replaced by inferior men, and even these could ill be spared. In future, arrangements will have to be made in the village to house these men properly and to arrange for their food being prepared at a fixed rate.

Apart from these seed-farms and the demonstration plots in their neighbourhood, there has been a rapid extension of drill

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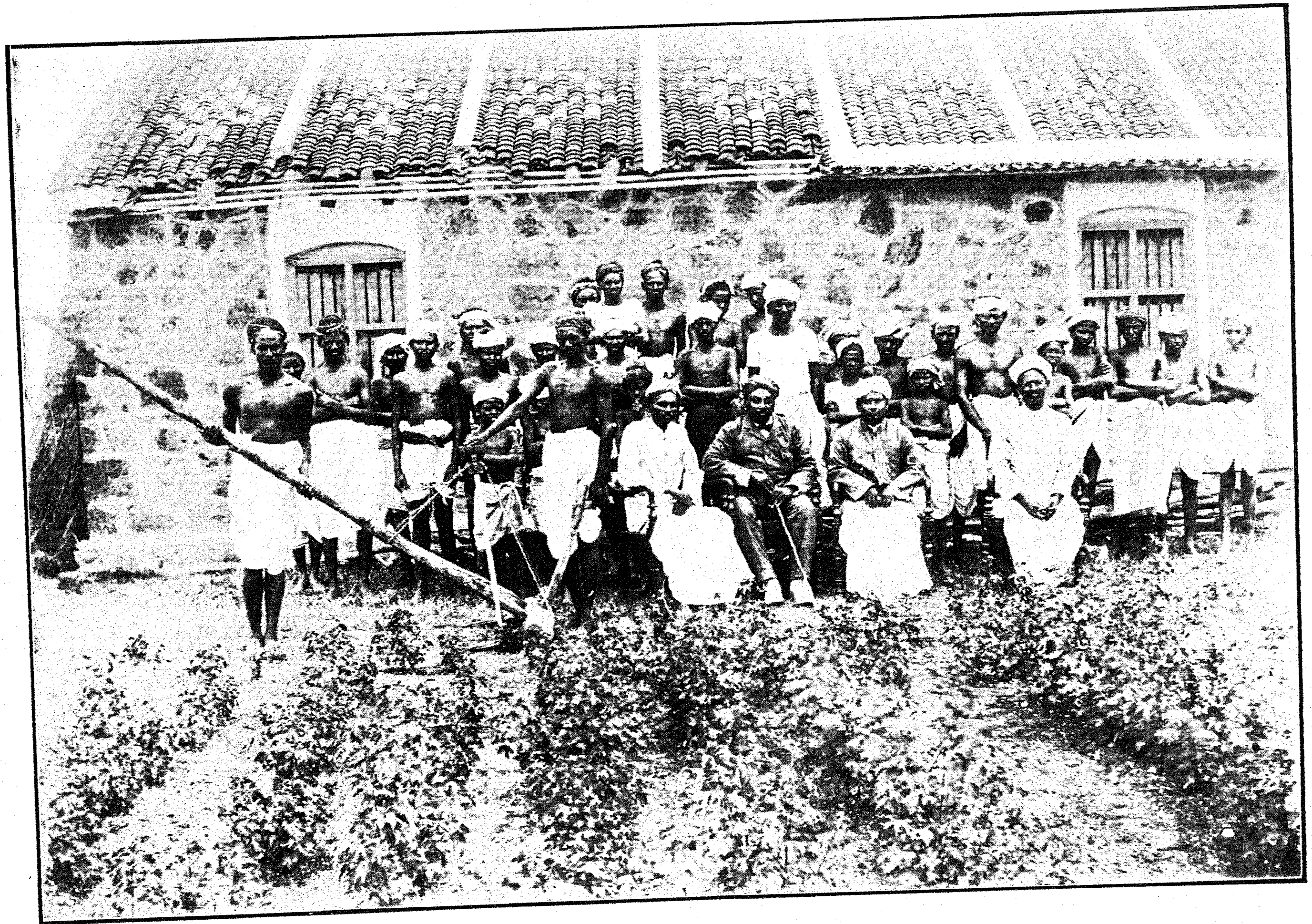
Apart from these seed-farms and the demonstration plots in their neighbourhood, there has been a rapid extension of drill

sowing in the villages around Koilpatty, where some 500 acres have been sown. One village alone accounted for more than 230 acres, while two more each had over 70 acres. In a few cases, outlying *ryots* have also sown, having either seen the farm crops last year or the crops of *ryots* who had sown with the drill the previous season. Including the seed-farms, there is an area of about 1,000 acres this year sown with the drill.

The mere fact of sowing is, however, by no means everything. Each *ryot* who has sown has to be seen constantly. He has to be induced to thin and shown, when and how, to use the bullock-hoe. As the thinning and, very often, the hoeing clash with other farm work, the *ryots* are often unwilling at the time to do so. They may make promises, but they do not always fulfil them. This means considerable patience and tact in dealing with them. Thinning especially goes against the grain, for the *ryot* says "It is like taking the life of my children to pull these plants which have grown," but still this must be done if this system of cultivation is not to degenerate into that of the Bellary District where the seed-rate is more than double that used in Tinnevelly and no thinning is done. Many of the wives and children of the Koilpatty coolie staff who are employed for casual labour on the Agricultural Station, have had to be pressed into service and sent out with one of the Assistant Managers to show *ryots* how to thin their crops. Small boys are probably the best, as their youth favours them in their training, and they can do the work with that unconscious confidence which always appeals to a *ryot*. With all the success already obtained in this introduction, it is by no means certain yet whether this method of cultivation, if now left to itself, would last. The questions which next present themselves are: (1) when should the Department withdraw its help, and (2) how to leave the work on a substantial basis. This is, of course, looking into the future, but it seems necessary that the Department should give some concession, but only if the *ryot* will do the same. The proposal next season is that the Department should lend one set of implements to the village for every one that the village is prepared to make,

PLATE XXIII.



STAFF OF KOILPATTY AGRICULTURAL STATION.

provided that 60 acres are sown with the two sets, and if the villagers among themselves guarantee to sow 200 acres with the drill, the services of a trained coolie will be lent to them for the season. To a very great extent, the success so far attained, has depended on the Manager and the Assistant Managers of the Koilpatty Agricultural Station. The Manager, M. R. Ry. A. V. Tirumurunganatham Pillai, has only been at this station for $3\frac{1}{4}$ years, joining as an Assistant Manager. On 14th December 1906, he was put in charge of the station, and it says much for him that he, not being a native of this district, should, in that time, gain the confidence of the neighbouring *ryots* as well as the loyal support of his Assisant Managers, and that he can entrust his own coolies, most of whom are Pariahs, to carry out his instructions when sent out into the district. The success of the seed-farms from the very first has largely depended on the untiring efforts of my Assistant, M. R. Ry. Chelvaranga Raju. It is no easy matter to supervise work in five separate centres scattered over four Taluks, especially when one has to travel through black cotton soil country in the monsoon season. Plate XXIII shows the staff who are carrying out this work. One of the Assistant Managers is not present as he is out on tour. The coolies represent the temporary establishment utilised both on the Agricultural Station and in the district. Many of them are not fully trained yet, as this includes the boys employed for thinning and for guiding the bullock-hoes.

NOTES.

Pine Apple Industry in India—In recent years, the demand for Indian-grown pine apples has so greatly increased that an effort should be made to establish this industry on a commercial scale.

The pine apple is grown extensively in many parts of India and Burma.

On the Malabar Coast, in Northern Bengal, in Assam and in Burma, the pine apple produces fruit of very good quality.

On the Khasi Hills in Assam, it grows excellently and yields a fine fruit.

There has been no particular effort made to develop the cultivation of the fruit on a commercial basis. Therefore, pine apples from the Straits Settlements, Ceylon and Mauritius, find a ready sale in India at remunerative prices.

A warm moist atmosphere, a fairly high rainfall, a friable soil and a porous sub-soil appear to be best suitable for pine apples in India.

Pine apples in India thrive well on soils which have been improved, in forests, by partial clearing and by the natural addition through rainfall of leaf mould. A friable moist soil with a fairly high proportion of organic manure is apparently essential for successful cultivation.

Pine apple plantations, when established 3 or 4 years, should be removed to suitable areas with the view of improving or renewing the vigour of the plant.

When the fruit is formed, numerous suckers grow round the parent stem. These can be used for propagation. Plants may

also be raised from the crown of leaves of the fruit, and from the black seeds of the fruit.

In plantation, the suckers should be planted in rows 3 feet apart.

In Bengal, the season for planting out pine apples is August. The plant there flowers in February and March, and its fruit ripens in July or August. In September and October, it makes its perfect growth.

Each fruit should be cut off with a sharp knife through the middle of the stock, a little before it is fully ripe, and for export should be very carefully packed in soft material, and in ventilated boxes to avoid fermentation and bruising.

The leaves yield a good fibre. In the London market it fetches about £30 (Rs. 450) per ton. In the Rangpur District of Eastern Bengal and Assam, the fibre is largely used by the shoe-makers as string. In the Southern Mahratha country and Goa, it is used for necklaces. The Fibre Expert to the Government of Eastern Bengal and Assam is, however, of opinion that the extraction of fibre from pine apple is not likely to be an extensive enterprise in any part of India—(EDITOR).

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THE REARING OF EDIBLE FROGS—Frog is a food-stuff in America, and its consumption in the United States is, according to the Commissioner of Fisheries for Pennsylvania, twice as much as in France. Frog farming might be a lucrative Indian industry in the future, if Indian farmers invest their money in this industry and utilise their waste and swampy lands, which they cannot otherwise make use of. On account of the great demand in the Foreign market, it can be made profitable.

The method of frog rearing is simple. In the beginning, a small pond about 60′ by 20′ should be made, in which to hatch the frog eggs and care for the tadpoles until they have developed into frogs. During the time these tadpoles are developed, at least three more ponds about the same size must be made, in which to place the crop of young frogs. When they

become two years old, they should be kept in separate ponds as they devour each other, as for instance, three-year old frogs eat one-year old frogs, and so on.

In order to protect them from snakes, water beetles, birds, such as cranes, herons and owls, the ponds should be fenced properly and watched. When three years old, they become ready for market—(M. A. Rashid).

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Sida Fibre—The *Indian Textile Journal* for November 1908 contains a long article on "Sida : a Substitute for Jute."

Sida has long been known as a fibre of considerable merit. In 1853, Major Hannay, of Assam, drew attention to it, and pointed out its various advantages. Efforts to popularise its cultivation were, however, not successful, chiefly perhaps, owing to the growing demand for jute ; but partly also, no doubt, owing to certain difficulties regarding its cultivation. One of these difficulties is the hardness of its seed, which refuses to germinate unless specially treated before sowing. Such hardness of the seed can easily be overcome, of course, by treatment with Sulphuric Acid, which attacks the hard coating and renders it permeable to water which promotes germination. Good germination can also be procured by treatment in a machine such as is used for the similarly hard seed of Java Indigo. These conveniences are, however, not at the disposal of every cultivator, and it is certain that, before any considerable extension of Sida cultivation could take place, a simple means of promoting germination must be prescribed. Experiments with this object in view, carried out in the laboratory of the writer of this note, now indicate that success may be realised by immersing the seed in hot water for a short time. A fifty per cent. germination has already been obtained from seed of which only 3% germinates before treatment, and it is hoped that more satisfactory results still will accrue from further work.

It may be remarked here in passing that a hard coating is very common indeed in the seed of jungle plants in India.

Moreover, it has been noticed that some cultivated plants when allowed to run wild, tend to produce hard seed in a comparatively short time, a fact which indicates the possibility of performing the reverse process in the case of Sida by careful cultivation and selection.

Another difficulty in cultivating Sida has, up to the present, been the great tendency towards branching which it exhibits, a habit which is, of course, an important disadvantage in a plant to be used for fibre production. At first it was thought likely that the difficulty could only be overcome by careful selection and breeding of a non-branching race; but Dr. Butler, the Imperial Mycologist, when touring in Burma, accidentally discovered a straight growing variety of Sida, which gives promise of solving this problem in a much easier manner.

Several varieties of Sida are to be found in various parts of India. The commonest are, perhaps, *S. rhombifolia* and *S. carpinifolia;* others less common are *S. veronicæfolia* and one which has been variously named, *S. spinosa* and *S. cordifolia.* This last and *S. rhombifolia* seem to yield fibre of better quality than others.

Regarding the merits of Sida, as compared with other fibres, Messrs. Cross and Beven, of London, found that one sample examined by them contained 83% of Cellulose as against 75% for jute. Such a high percentage of Cellulose would place Sida on a level with *Rhea* and flax, whereas the writer's results indicate so far that jute and Sida are very similar as regards Cellulose content.

It may be pointed out that Cellulose is the ingredient in a fibre which makes for durability.

Nevertheless, although Sida is probably nearer to the standard of jute than to that of flax, as regards quality, there is reason to believe that its fine texture would enable it not only to replace the higher classes of jute, but even to be used for purposes for which jute would be unsuitable. Two years ago, the Indian Jute Mills valued one sample of Sida at Rs. 11 per maund, when the average quoted value for jute was Rs. 8 per maund, and more

recently, another sample has been valued in London at from £ 25 to £ 30 per ton with good to fine jute at £ 16 to £ 25 per ton. These figures are encouraging, but it must be remembered that Sida will probably never be capable of yielding such a weight of fibre per acre as jute. Moreover, the expenses of cultivation are likely to be rather higher than for jute. The writer has obtained over six maunds per acre which, with the longer and straighter plant recently discovered, may be increased to ten maunds per acre. Such a yield might pay quite well. At the same time, having regard to all considerations, it would appear that the time has not yet come to recommend Sida for commercial exploitation as a fibre plant. It may be possible to do so after a short time; but until the points at issue have been decided, such a course would probably rather hinder than help the development of a fibre which may easily have a great future in the textile world—(R. S. FINLOW).

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VISITORS TO AGRICULTURAL COLLEGES AND FARMS—The Government of Madras have appointed, for two years, 15 non-official gentlemen of the Presidency, who take a practical interest in Agriculture, as honorary visitors to the Agricultural College and Research Institute at Coimbatore. The College and Farm will be open for their inspection at any time except on Sundays and on Government Gazetted holidays, and an officer will be deputed to show them anything they may wish to see and to afford any information regarding the object of any experiments that may be in progress. Every honorary visitor intending to visit the College or Farm shall ordinarily give the Principal 24 hours' notice of such intention.

A visitor's book will be kept in the Principal's office in which the visitors may enter any remarks and observations they may wish to record regarding the work in progress in the College or Farm. Copies of remarks recorded by visitors will be forwarded, by the Principal, once a quarter, to the Board of Revenue through the Director of Agriculture.

Somewhat similar arrangements might be followed in the other Provinces with advantage—(EDITOR).

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COTTON CULTIVATION IN MADRAS—The Government of Madras sanctioned the proposals of the Director of Agriculture for the utilisation of a grant of Rs. 5,000 provided in the budget of 1908-9 for the improvement of cotton cultivation in that Presidency. The Director proposes to confine the expenditure almost entirely to the Tinnevelly District and to spend a small sum in Trichinopoly.

Experiments have shown that *Karangani* Cotton is superior in quality and a more paying crop than the *Uppam* variety. Arrangements were, therefore, made last season to distribute pure Karangani seed sufficient to sow about 7,000 acres. The *Kapas* was ginned by the department, and the lint sold, the seed being kept for distribution.

There was a keen demand for seed. About 250 acres of *ryots'* land were sown with selected seed under departmental supervision. The ryots were refunded the assessment of the land, and the agricultural department provided one trained coolie and one pair of locally hired bullocks at sowing time for every thirty acres. In this way improved methods of drilling the seed and of interculture were demonstrated. Careful preliminary tillage and manuring were insisted on.

The advantages of the drill are becoming widely appreciated, and in all, 1,000 acres of private land have been sown with the drill this year, about 400 acres of which are in the village in which the Koilpatty Government farm is situated. The facts that with the drill a much larger area can be sown in a given time than with the plough, and that sowing can be continued longer after the rain stops, are beginning to be understood by the *ryots*. Many ryots have learned to use the drill and have taught their women to sow the seed. Mr. H. C. Sampson, Deputy Director of Agriculture, writes :—

"The introduction of this system of cultivation is, I consider, the most important work that is being done. In seasons of

drought, such as this, the *ryot* has to depend almost entirely on his cotton crop for his livelihood, and if he can be shown that this system of cultivation can help the cotton crop to withstand the drought and to give even a fair crop in such seasons, it may mean all the difference between scarcity and famine."—(EDITOR).

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MILK RECORDS—An interesting paper on this subject was lately read before the Farmers' Club by an Essex dairy farmer, in which were some remarkable figures showing the results obtained by a systematic selection of the milking herd. On one day in each week the milk given by every individual cow was carefully measured and recorded. Not only did this practice enable the owner to estimate with considerable accuracy the profit and loss on each cow; but it was also of greater value as a guide to show from which cows the calves should be reared. Thus, the selection of the cattle from which to breed was based almost entirely upon the milking capacity of the cow, and a good 'milk'—rather than a good show—pedigree was desired. The other factor necessary for the improvement of the herd was a supply of sires from a good milking stock, that is, bulls from other herds where the same or similar records had been kept. In the paper read it was emphasized that a 'good-looking bull,' or even a pedigree bull, if from a herd bred simply for beef or points, was not necessarily of any value; all that was required was one whose female stock would probably be better milkers than their dams.

By carefully selecting and breeding on these lines, the speaker had improved his stock to such an extent, that he now owned heifers which, at two and a half years old, after giving birth to their first calf, gave fourteen quarts of milk a day instead of the ten to eleven quarts that were the record for the same class a few years ago.

The ideas and methods advocated in the paper are not new, and some such selection is now carried out by most of the larger dairy farmers with more or less success. But the point that

is worthy of note by readers in this country is the result achieved. And if, even among the more highly selected cattle of England, whose milk producing powers have been continuously forced, so marked an improvement can be made within so short a time, then surely, it is reasonable to expect yet better results from an Indian herd if carefully and systematically selected to that end—(G. SHERRARD).

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CULTIVATION OF WILD RHEA—Wild Rhea is identified by the Hill tribes of Assam as the *Villebrunea integrifolia* plant. This is found profusely at the foot of the Eastern Himalayas from Sikkim to Nepal, throughout the Valley of Assam, especially near the foot of the hills and within the Assam Hills from the extreme north through the Naga Country to the Khasia and Garo Hills, thence to Manipur, Cachar, Sylhet and Chittagong, also in the mountainous tracts of Burma as far as Tenasserim and to the Yunan Province of China, in the damp valleys of the higher Konkan Ghats and even in the Andaman Islands. It grows in damp glades near streams, but its roots are always above water. It is extremely pollarded, and a place called *Riha-Kata-Jan* is said to be the head-quarters of the Mikir collection and preparation of this bauriha-fibre. It is said to be an indigenous plant and quite distinct from the cultivated Rhea. Expert investigation has shown that the fibre of this plant is exceedingly fine as compared with that of ordinary Rhea, its filaments long and strong, and its material capable of producing finer textile fabrics than *Boehmeria nivea*, and a good substitute for fine linen.

In making cloth, it is mixed with silk. In the village markets of Assam, the Garos who principally deal in the fibre, sell it at Re. 1 per seer. The stems which yield the fibre are obtained by cutting down the plants during the months of November to February. Young shoots again sprout in June and during the rains. The fibre is extracted from the branches in the same way as from *Boehmeria nivea*. The Assamese take off the ribbons

when the shoots are half dry and do not first scrape off the outer bark or gum. They leave the inner face coated with slimy green and purify it in a coarse way by washing in lime and then twist it into twine or simply divide up the ribbons and without any preparation, twist these into twine to be used for making nets for catching gang—(S. C. SANIAL).

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CULTIVATION OF MAIZE IN THE PAKOKKU DISTRICT OF UPPER BURMA.—It is a curious fact and one, I think, not widely known that Maize (*Zea mays*) is entirely grown in this district, and I think I may say, all over Burma, for the wrapper which envelops the cob, and not for the grain found on that cob.

This wrapper or "pet" as it is called by Burmans, is used for cheroots; not the Burman cheroots known as such out of Burma, which are smoked usually by non-Burmans, but for the cheroots actually smoked by Burmans.

These consist of a quantity of coarse tobacco leaf and stalk chopped up and mixed with chopped wood of the "Ohnnebin" tree (*Streblus asper*) wrapped in a fold or two of "pet," or in the leaf specially prepared of the "thanat-bin" (*Cordia myxa*).

That the demand for "Pyaung-bu-pet," *i.e.*, Maize "pet," is great, is proved by its price.

All that is exported from the district finds its way out through Pakokku town, where it is shipped on board the steamers of the Irrawaddy Flotilla Company, and carried down to the delta. In the town of Pakokku the price of the best "pet" is Rs. 100 per 100 viss of 3·66 lbs. each.

It is mainly grown in the western townships of the district. The local price varies from Rs. 50 to Rs. 70 per 100 viss, that is, the price in the villages in which it is grown. The crop is put down in June and ripens in October-November. The cobs, as they ripen, are broken off the stalks on which they grow. The wrapper is then carefully cut off each cob and tied up in neat bundles of from one to one and a half viss each. It is said that the work of cutting off the "pet" and tying it in

bundles is not easy. The process certainly looks very simple. Men are hired for it, and the regular hire is Re. 1 for 10 viss. The maize cobs are sold, and for the last three years, have been the means of staving off dire distress in the eastern townships of the district. The demand for them, as a food, has caused their price to rise as high as Re. 1 for three baskets. The cobs are sold; not the grain only without the cobs. The grain is not relished by Burmans as a food, and only the fact that no other food is obtainable, induces them to eat it. This, I think, is due to the fact that the cookery science of the Burman is common with all Indo-Chinese races and is confined to the art of boiling.

Rice, millet, meat, vegetables are all cooked by boiling, and maize grain, after the hard outer shell has been removed by pounding, is cooked in the same manner. It would probably be far more palatable, if reduced to flour and baked into bread or cakes.

Those fortunate enough to own maize-growing land would laugh at the idea of eating maize grain.

The crop is a very paying one. The yield per acre ranges from 30 viss to 60 viss, and many plots yield as much as 100 viss to the acre. The number of baskets of cobs from a given area is almost identical with the number of viss of "pet."

I was told on my first arrival in the district in October 1905 that the cobs with the grain on them were often thrown away. —(F. C. Owens).

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Selection of Sea Island Cotton in Georgia, United States of America—About 1785 seeds of this cotton were brought to Georgia from the Bahamas. Notwithstanding the good care they received and the mild winter, the plants were killed down, but they came up again from the roots, and with this start succeeded in ripening a few seeds before the first frost in the fall. The earliest of these seeds were sown in turn, and by continuing this process of selection the flowering period became earlier and earlier, until now the plants ripen a large portion of their seeds

before frost, even along the Coast of Carolinas. Besides striving to obtain earlier maturing sorts, very careful selection has for years been made with a view to increasing the length, fineness and strength of the staple. The selection is regularly practised by all intelligent growers, and to-day it may be regarded as one of the necessary cultural methods. Every year a special patch of cotton is grown from selected seed; the plants in this patch are examined very carefully and the seeds of the best individuals retained for planting a similar patch next year, the seeds of the remaining plants being used to plant the general crop. Under such continuous and rigorous selection the length and fineness of the fibre have gradually increased until it is recognised as superior to that grown anywhere else in the world, and commands the highest price in the market. It is, moreover, only by such selection that the quality of the fibre can be maintained at its present superior standard. This method of selection and similar ones are applicable with slight variations to most of our common crops, such as maize, wheat, etc.—(W. ROBERTS).

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SERICULTURE IN JAMMU—The soil and climate of Jammu are quite suitable for the growth of Mulberry trees on a large scale. *Morus nigra* is absent in the sub-mountainous districts and in the plains, but *Morus alba vulgaris* is plentiful. *Morus serrata* or the fruitless Mulberry trees are also common in Jammu and afford good food to the *Bombyx mori* or the Mulberry silkworm. The grafted *Morus indiga* or the Shahtut is found in many gardens, but it does not make good food for the silkworms at the beginning of its growth. It may be used just before the silkworms ascend for seri-depositing.

The common *Ber* (*Ziziphus jujuba*) tree, the good food for *Antheræa myletta* or the Tussar silkworm, grows largely in Jammu. The castor oil plant (*Ricinus communis*), the food of *Attacus ricini* or Eri silkworm, is also very common here. As such, there is a large source of food-supply for silkworms for which rearing operations can probably be advantageously begun.

On an average, 20 good Mulberry trees of 7 or 10 years old afford sufficient food for one ounce of seed. Under favourable conditions, these worms yield about one maund of green cocoons, *i.e.*, every hundred Mulberry trees can yield 5 maunds of cocoons. The price paid to rearers for cocoons is about Rs. 15 per maund. Approximately 5 maunds of green cocoons feed 80 reeling basins working for a full day and yield 30 lbs. of best raw silk. The rearing season begins in Jammu about the first week of March and ends about the first week of May, when temperature averaging from 70° to 80° remains in the shade. In 1907, 1,500 ounces of seed were distributed, but the results of rearing were poor, as 1,025 ounces of seed produced 485 maunds of cocoons as compared with an yield of 304½ maunds from 350 ounces of seed in the previous year. The rearing of Tussar silkworms is being taken up. Wild Tussar is commonly produced on the *Ber* trees. Experiments are also being made to rear Eri silkworms fed on castor oil plant—(Editor).

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Field, Garden and Orchard Crops of the Bombay Presidency—Mr. G. A. Gammie, as Economic Botanist, Bombay, drew up in 1907, after eight years' observation, some notes on Field, Garden and Orchard Crops of the Bomay Presidency, mainly for the use of students and others interested in Agricultural Botany. These are now published in Bulletin No. 30 (1908) by the Department of Agriculture, Bombay. The botanical diagnosis of orders, genera and species are, in all cases, restricted so as to elucidate only the plants actually described. Mr. Gammie hopes to bring out shortly an illustrated edition of these notes with additions and corrections—(Editor).

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American Cotton Cultivation in India.—The second auction of American cotton in the Jhelum Colony took place at Sargodha in January last, over 1,100 maunds being brought in. A gratifying feature of the sale was the appearance of representatives of the Delhi and Cawnpore mills, as it is probable that these mills can turn the quality of cotton to the best account. The

ultimate purchasers were the Muir Mills of Cawnpore, at Rs 7-7-0 per maund. This compares favourably with rates ranging from Rs. 5-8-0 to Rs. 6 for Deshi cotton on the same day, and with Rs. 7-5-3 realised at the first auction.

The auction system has placed the experiment on a much sounder footing than before; the produce is more widely known, and a better idea has been obtained of its market value. The growers have been brought into touch with the trade and have grasped the importance of marketing their crop free from admixture.

It would be premature to think that the cultivation of American cotton has been established; it must not be forgotten that the outturn per acre in 1907 was much less than with Deshi cotton and that the growers were out of the pocket. But they did well on previous occasions, and have done extremely well in 1908. The past season has suited American cotton as it has yielded much more heavily than Deshi, besides fetching a higher price.

The year's results may be regarded as encouraging, and it is certain that there will be an appreciable extension of cultivation in the Spring—(EXTRACT FROM THE "*Times of India*").

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JUTE IN ASSAM—The *Indian Agriculturist* for November 1908 contains an interesting article and also an editorial on the prospects of jute cultivation in Assam as an outlet for European enterprise. Two plantations, Baroma and Patimari, were opened out in Kamrup District during the year 1906-7, both on newly-cleared jungle land on the north bank of the Brahmaputra. At present, there is no railway communication, and the nearest town is Gauhati which is across the Brahmaputra, forty miles from Baroma and nearly twenty miles from Patimari. Both plantations are, however, within fairly easy reach of the Dhubri-Gauhati extension of the Eastern Bengal State Railway, which is now nearly ready for traffic.

Away from the river and nearer the foot hills of the Himalayas, there is a good deal of land in Northern Assam not at

present under cultivation, which is covered by more or less dense reed jungle. This jungle by preventing the flow of water deposited by the heavy rains keeps land in a swampy condition which, when cleared, has an ample gradient for sufficient drainage. Bearing this in mind and remembering also that such soil contains the more or less imperfectly decomposed remains of many generations of plant growth, it is not surprising that it has been found necessary to open up the land sometime before sowing jute in order to allow it to become sufficiently aerated and weathered. So far, experience indicates that the best plan is to clear the jungle and break up the land with the "Kadauli" or a deep plough in the early cold weather. Ploughing is continued at intervals until April, after which the land is allowed to lie fallow until September. Cultivation then recommences for a cold weather mustard crop, which is best sown in September, though it may be put down as late as the middle of November. In this way the land is rendered comparatively free from weeds, and after the mustard has been taken off, three or four ploughings and one or two ladderings are sufficient preparation for the sowing of jute. It remains to be seen whether, instead of leaving the land fallow for 6 months, it would not pay to put it under Sann-hemp which, besides enriching the soil with Nitrogen, is itself a very effective clearing crop because its thick growth stifles weeds.

That the land in this part of Assam is naturally rich is proved by the very large crops of jute which have been produced on it. Moreover, owing probably to the comparative purity of the retting water, the fibre is of very fine quality so that it commands a high price in the market. The rainfall of the district is heavy and well distributed and the temperature high enough to produce the rapid growth necessary in jute. Local labour is fairly plentiful in Kamrup, but the population of this district is probably denser than that of any other part of the Assam Valley. In most districts, it would be necessary to import labour if the putting of a large area under jute were contemplated.

The article states that the retting and steeping of the

jute cost more than the actual cultivation. This is probably true if untrained labour is used; it is within the experience of the writer of this note that untrained coolies have only been able, at first, to strip about 3 to 4 seers of dry jute a day, while a really good man can turn out upwards of a maund. Assuming an average wage of annas 6 per day, it is plain that the cost of the stripping process may be anything between annas 6 and Rs. 3-12-0 per maund.

Two years ago with the price for jute of average quality at Rs. 10 and over per maund, it paid to grow the crop, even at an extravagant cost of production; but the present price of Rs. 5 to Rs. 6 per maund renders it essential that expenses should be reduced as much as possible, and the inducement to Europeans to take up its cultivation is consequently not so great as it was. It would certainly be inadvisable, now, to put a large area under jute and attempt to work it off with untrained labour; but it would be different if it were proposed to put down only a small area at first with the object of increasing the acreage later as the experience of both Manager and coolies justified the expansion. In fact, with normal prices, the same rule applies to jute as to tea or to indigo; no one would think of taking up the planting of either of the latter crops on a large scale without knowledge, based on experience, not only of the special manufacturing process, but also of the agricultural operations involved. Under these conditions, jute is still capable of yielding a reasonable profit to the European planter.

Attention is drawn in the article to the practice which obtains among buyers of systematically deducting a certain percentage from the weight of every consignment of jute on account of excessive moisture. There is no doubt, of course, that a large quantity of imperfectly dried jute comes into the market, and buyers are bound to protect themselves; but if some discrimination in the way of better prices could be made between genuine and watered consignments, it could hardly fail, in the end, by encouraging honest dealing, to be advantageous both to the producer and to the buyer of jute—(R. S. FINLOW).

REVIEWS.

PROCEEDINGS OF THE 15TH SERICULTURE CONFERENCE HELD AT SRINAGAR ON THE 23RD OCTOBER 1908, IN THE PRESENCE OF THE RESIDENT IN KASHMIR.

THE Proceedings show that in Kashmir during 1907-8, about 20 maunds of picked cocoons were received for breeding, and each moth was microscopically examined for disease. About 28,000 ounces of seed were distributed to 8 Tahsils. The number of rearers was 18,949 during 1907-8, being an increase of 1,900 over the previous year. The crop of cocoons was 23,490 maunds, 17 seers from 27,954½ ounces of seed, *i.e.*, an ounce of seed yielded 33 seers, 9 chhataks of cocoons. The new filatures are being fitted with electricity from the Jhelum, both for heating the water and turning the reels. The State Electric Department has made prolonged experiments in regard to the electric killing of cocoons, which show that by using tin-lined cases of 90 cubic feet capacity and by taking 6-7 h.-p. to kill 10 maunds of cocoons, each lot would take 2 hours 40 minutes to kill effectively. The Chief Engineer, Electric Department, remarks that electrocution would take less than one-third of the time required for *sechoir* killing, and that 13 boxes, as described above, could deal with 1,000 maunds in 24 hours. The experiments so far made, tend to show that the electrically killed cocoons give an enhanced production of silk. Further experiments as to this are being made. Taking the cost of electricity at £8 (Rs. 120) per h.-p., the cost of killing one maund of cocoons would be 10 annas 6 pies, considerably less than the cost of *sechoir* killing. Besides, the whole of the plant could be made locally at small cost. But about this, nothing has been finally decided.

In 1908, 240 bales of silk were sold at an average price of 12*s.* 11*d.* per lb., and the balance sheet for the year shows a net profit of Rs. 6,15,007.

The Silk Weaving Department of Kashmir is still working at a loss, and it cannot be made lucrative unless the factory is provided with expert weavers. The experimental filature for Jammu Sericulture is reported to be working satisfactorily, and the labour supply is increasing. A few seers of silk were sold at about Rs. 11-10-8 per lb. About 45 Mulberry nurseries have been made in 10 Tahsils, and arrangements are being made for storing cocoons—(EDITOR).

* * *

ANNUAL REPORT ON THE WORKING OF CO-OPERATIVE CREDIT SOCIETIES IN THE BOMBAY PRESIDENCY (INCLUDING SIND) FOR THE YEAR 1ST JULY TO THE 30TH JUNE 1908.

THE steady progress of the Co-operative Credit Banks among the agricultural population of the Bombay Presidency shows that the principle of Co-operative Credit has begun to be understood. In the year under notice there were 145 Societies as compared with 69 during the year before. Of them, 99 are Rural, consisting mainly of agriculturists, and 46 Urban.

In Bombay there is no Central Society. The "Bombay Urban" and the "Broach District Society" are centres for lending to Rural Societies. In the year under review, loans were given by them at $9\frac{3}{8}\%$ interest.

The number of members of Urban Societies rose from 1,930 at the beginning of the year to 3,327 at its end. Those of Rural Societies rose from 5,405 to 8,477. The working capital of Urban Societies was Rs. 1,93,040, whilst that of Rural Societies was Rs. 3,69,880.

Government asked for information on the prevailing rates at which agriculturists borrow from money-lenders. The differences in the rates of interest vary greatly, but cannot be accurately ascertained. The average rate in the Presidency is probably about 18 per cent. per annum.

Repayment of loans during the year was creditable notwithstanding the "ignorance of summary procedure for recovery." Certain facilities to recipients of loans have been granted, which should help the formation of new societies—(EDITOR).

*
* *

BEHAR PLANTERS' ASSOCIATION, LTD. ANNUAL REPORT OF THE DIRECTORS TO THE MEMBERS OF THE ASSOCIATION FOR 1907-08.

THE Association continued to receive the grant of Rs. 50,000 from the Bengal Government for Indigo Research work at Sirseah. A Sub-Committee is chiefly responsible for the work. Eight publications on Indigo were issued by the Sirseah Committee and circulated.

In view of the expiration of the grant on the 31st March 1909, the Directors of the Association have submitted a scheme to the Bengal Government for further aid.

The Bengal Government made a grant of Rs. 7,500 to the Association for the services of a flax expert and purchase of seed. During the year, Mr. Emil Vanderkerkhove, a practical Belgian farmer, was employed as flax expert. The Inspector-General of Agriculture in India and the Director of Agriculture, Bengal, visited Dooriah, and after a thorough enquiry regarding the usefulness of flax as a commercial crop in Behar, advised the Association to retain Mr. Vanderkerkhove's services for another five years for the further development of the flax industry in India. Accordingly an agreement has been entered into between Mr. Vanderkerkhove and the Association from the 1st April 1908 to the 31st March 1913. The total cost of his services will amount to Rs. 5,500 annually, and this sum will be paid conjointly by the Government of India and the Bengal Government. Three circulars on flax were issued.

The Report states that the loan given by the Bengal Government to the Manager of the Benipore Sugar Factory was repaid by the Association.

Circulars on artificial and natural indigo, sugar, jute, rice, cotton, poultry, manuring, cattle-breeding, oats, wheats,

country crops and lac, were also issued and distributed by the Association—(EDITOR).

*
* *

A CHEMICAL AND PHYSICAL STUDY OF THE LARGE AND SMALL FAT GLOBULES IN COW'S MILK BY R. H. SHAW AND C. H. ECKLES (BULLETIN No. III OF THE BUREAU OF ANIMAL INDUSTRY, UNITED STATES DEPARTMENT OF AGRICULTURE).

A NUMBER of new questions in dairy management have been raised by the widely extended use of the cream separator, which has enabled a much larger amount of butter to be obtained from a definite weight of milk than was previously possible. Among these is one which is, we think, finally set at rest by the publication now under consideration. The fat globules of milk may be divided into two groups of different sizes. The larger of these rise to the surface easily, and form the bulk of the cream obtained when this is allowed to rise naturally. The smaller particles of fat do not separate under these conditions: they are only made available for butter-making when the milk is passed through a separator. The higher the speed of the separator the smaller will be the particles of fat which are actually removed. It has often been suggested that these latter portions of fat derived from the smaller globules are not of the same composition as those which rise first, that they are most wax-like, that they have a higher melting point, and that they, hence, form a stiffer butter. The present bulletin shows, we think, conclusively, that there is, so far as cows in America are concerned, nothing in the suggestion. The fat, from the same milk, however separated, has essentially the same composition, and the use of the separator has not introduced any alteration in the quality of butter on this account. Any change or deterioration in the value of butter on the introduction of separators is due to some other cause than the composition of the fat globules which the milk originally contains.

LIST OF AGRICULTURAL PUBLICATIONS IN INDIA FROM 1st AUGUST 1908 TO 31st JANUARY 1909.

No.	Title.	Author.	Where published.
		General Agriculture.	
1	*Agricultural Journal of India*, Vol. III, Part IV. Price Rs. 2. Annual subscription Rs. 6.	Agricultural Research Institute, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.
2	*Agricultural Journal of India*, Vol. IV, Part I. Price Rs. 2. Annual subscription Rs. 6.	Ditto.	Ditto.
3	Seed Time and Harvest Time of Crops grown in Bengal. (Not for sale).	Department of Agriculture, Bengal.	Department of Agriculture, Bengal.
4	Flax in Behar. Departmental Records No. 1 of 1908. (Not for sale).	Ditto.	Ditto.
5	Annual Report of the Bengal Agricultural Department for the year ending 30th June 1908. Price annas 8.	Ditto.	Bengal Secretariat Book Depôt, Calcutta.
6	Annual Report of the Cuttack Agricultural Station for the year 1907-08. Price annas 4.	Ditto.	Ditto.
7	Annual Report of the Dumraon Agricultural Station for the year 1907-08. Price annas 4.	Ditto.	Ditto.
8	Annual Report of the Burdwan Agricultural Station for the year 1907-08. Price 4 annas.	Ditto.	Ditto.
9	Annual Report of the Tasar Silk Rearing Station, Chaibassa, Bengal, for the year 1907-08. Price 4 annas.	Ditto.	Ditto.
10	*Quarterly Journal* of the Agricultural Department of Bengal, Vol. II, No. 1. Price annas 8 per copy with postage.	Ditto.	Ditto.
11	*Quarterly Journal* of the Agricultural Department of Bengal, Vol. II, No. 2. Price annas 8 per copy with postage.	Ditto.	Ditto.
12	Implements, Manure and Seeds. Departmental Record No. 2 of 1908. (Not for sale).	F. Smith, B.Sc., Deputy Director of Agriculture, Bengal.	Department of Agriculture, Bengal.
13	Simple Notes on Common Cattle Diseases of Bengal. Leaflet No. 6 of 1908.	D. Quinlan, M.R.C.V.S., Superintendent, Civil Veterinary Department, Bengal.	Ditto.
14	Agricultural Statistics of Bengal for 1907-08. Price annas 8.	Department of Agriculture, Bengal.	Ditto.
15	Area and Yield of certain Principal Crops in India for the various periods from 1893-94 to 1907-08. Price 5 annas.	Commercial Intelligence Department, India.	Government Printing, India, Calcutta.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
		General Agriculture—contd.	
16	Report of the Indigo Research Station, Sirseah, for the year 1908-09.	Cyril Bergtheil, Imperial Bacteriologist.	Behar Planters' Association, Mozufferpore.
17	Annual Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June 1908. Price 8 annas.	Department of Land Records and Agriculture, United Provinces.	Government Press, United Provinces Allahabad.
18	Annual Report on the Cawnpore Agricultural Station for the year ending 30th June 1908. Price Re. 1.	Ditto.	Ditto.
19	Annual Report on the Jalaun (Orai) Agricultural Station for the year ending 30th June 1908. Price 8 annas.	Ditto.	Ditto.
20	Note on the Demonstration and Experimental factories worked during the Sugar Season, 1907-08.	Khan Bahadur Saiyid Mohamad Hadi, M.R.A.C., M.R.A.S., Assistant Director, Land Records and Agricultural Department, United Provinces.	London Printing Press, Lucknow.
21	American Cotton and the Method of its Sowing (in Urdu and Hindi). Leaflet.	Department of Land Records and Agriculture, United Provinces.	Newal Kishore Press, Lucknow.
22	Report on the Operations of the Department of Agriculture, Punjab, for the year ending 30th June 1908. Price 3 annas.	Department of Agriculture, Punjab.	*Civil and Military Gazette* Press, Lahore.
23	Annual Report of the Lyallpur Agricultural Station for 1907-08. Price 5 annas.	Ditto.	Ditto.
24	Annual Report of the Department of Agriculture of the Bombay Presidency for the year 1907-08. Price 5 annas.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
25	Annual Report on the Experimental Work of the Surat Agricultural Station for the year 1907-08. Price 14 annas.	Ditto.	Ditto.
26	Annual Report on the Experimental Work of the Dharwar Agricultural Station for the year 1907-08. Price 12 annas.	Ditto.	Ditto.
27	Annual Report on the Ganeskhund Botanical Station. Price 5 annas.	Ditto.	Ditto.
28	Annual Report on the Bassein Botanical and Agricultural Station. Price 4 annas.	Ditto.	Ditto.
29	Annual Report on the Experimental work of the Dhulia Agricultural Station for the year 1907-08. Price 5 annas.	Ditto.	Ditto.
30	Season and Crop Report of the Bombay Presidency for 1907-08. Price 7 annas.	Ditto.	Ditto.
31	Field, Orchard and Garden Crops of the Bombay Presidency: Bulletin No. 30 of 1908. Price 12 annas.	G. A. Gammie, F.L.S., Economic Botanist to the Government of Bombay.	Ditto.
32	Establishment and Management of the Dairy Farm: Bulletin No. 31 of 1908. Price 3 annas.	G. K. Kelkar, Assistant Professor of Agriculture, Poona.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
33	Annual Report of the Experimental Work of the Nadiad Agricultural Station for the year 1907-08. Price 6 annas.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
34	Annual Report on the Experimental Work of the Mnvalia Agricultural Station for the year 1907-08.	Ditto.	Ditto.
35	Annual Report on the Experimental Work of the Mirpurkhas Agricultural Station for the year 1907-08. Price 8 annas.	Ditto.	Ditto.
36	Annual Report on the Experimental Work of the Daulatpur Reclamation Station for the year 1907-08. Price 3 annas.	Ditto.	Ditto.
37	Annual Report on the Experimental Work of the Manjri and Lonavala Agricultural Stations for the year 1907-08. Price 5 annas.	Ditto.	Ditto.
38	Annual Report on the Experimental Work of the Kirkee Civil Dairy Farm for the year 1907-08. Price 4 annas.	Ditto.	Ditto.
39	Annual Report on the Experimental Work of the Agricultural College Station, Poona, for the year 1907-08. Price 4 annas.	Ditto.	Ditto.
40	Report of the Operations of the Department of Agriculture, 1907-08. Price 6 annas.	Department of Agriculture, Madras.	Government Press, Madras.
41	Scientific Report of the Hagari Agricultural Station for the year 1907-08. Price 2 annas.	Ditto.	Ditto.
42	Scientific Report of the Bellary Agricultural Station for the year 1907-08. Price 2 annas 3 pies.	Ditto.	Ditto.
43	Scientific Report of the Palur Agricultural Station for the year 1907-08. Price 8 annas.	Ditto.	Ditto.
44	Scientific Report of the Samalkota Agricultural Station for the year 1907-08. Price 3 annas.	Ditto.	Ditto.
45	Scientific Report of the Nandyal Agricultural Station for the year 1907-08. Price 1 anna 6 pies.	Ditto.	Ditto.
46	Scientific Report of the Taliparamba Agricultural Station for the year 1907-08. Price 6 annas.	Ditto.	Ditto.
47	Scientific Report of the Koilpatti Agricultural Station for the year 1907-08.	Ditto.	Ditto.
48	"Sann-hemp" (*Crotalaria juncea*): Bulletin No. 59. Price 1 anna.	Rao Bahadur C. K. Subba Rao, B.A.	Ditto.
49	Agricultural Calendar for 1909. (In English, Tamil and Telugu). Price 1 anna.	Department of Agriculture, Madras.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
		General Agriculture—contd.	
50	Report on the Working of the Department of Agriculture, C. P., for the year 1907-08. Price Re. 1.	Department of Agriculture, Central Provinces.	Central Provinces Secretariat Press, Nagpur.
51	Report on the Agricultural Stations in the Central Provinces for the year 1907-08. Price Re. 1.	Ditto.	Ditto.
52	Report on the Management of the Provincial and District Gardens in the Central Provinces for the year 1907-08. Price Re. 1.	Ditto.	Ditto.
53	How to Apply Nitrate of Soda as a Manure for Cotton.	D. Clouston, M.A., B.Sc., Deputy Director of Agriculture, Central Provinces.	*Deshsewak* Press, Nagpur.
54	Varieties of Potatoes grown in the Central Provinces : Bulletin. Price Re. 1.	G. Evans, B.A. (Cantab.), Deputy Director of Agriculture, Northern Circle, Central Provinces.	Central Provinces Secretariat Press, Nagpur.
55	*Agricultural Gazette*—a monthly publication. Price 2 annas per copy.	D. Clouston, M.A., B.Sc., Deputy Director of Agriculture, Central Provinces.	*Deshsewak* Press, Nagpur.
56	Annual Report of the Dacca Agricultural Station for the year ending 30th June 1908. Price 2 annas.	Department of Agriculture, Eastern Bengal and Assam.	Eastern Bengal and Assam Secretariat Press, Shillong.
57	Annual Report of the Jorhat Agricultural Station for the year ending 30th June 1908. Price 2 annas.	Ditto.	Ditto.
58	Annual Report of the Rajshahi Agricultural Station for the year ending 30th June 1908. Price 2 annas.	Ditto.	Ditto.
69	Annual Report on the Tropical Plantation at Wahjani for the year ending 30th June 1908. Price 2 annas.	Ditto.	Ditto.
60	Annual Report of the Rangpur Agricultural Station for the year ending 30th June 1908.	Ditto.	Ditto.
61	Annual Report of the Shillong Fruit Garden for the year ending 30th June 1908.	Ditto.	Ditto.
62	Annual Report of the Upper Shillong Agricultural Station for the year ending 30th June 1908.	Ditto.	Ditto.
63	Potato Cultivation : Bulletin No. 21 of the Eastern Bengal and Assam Department of Agriculture.* Price 1 anna.	Ditto.	Ditto.
64	How to Water Fruit Trees: Leaflet No. 2.	Ditto.	Ditto.
65	Central Seed Depôt, Dacca: Leaflet No. 3.	Ditto.	Ditto.

* With Bengali and Assamese translations.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	General Agriculture—concld.		
67	Report on the Operation of the Department of Agriculture, Eastern Bengal and Assam, during the year ending the 30th June 1908.	Department of Agriculture, Eastern Bengal and Assam.	Eastern Bengal and Assam Secretariat Press, Shillong.
68	Cultivation of English Vegetables, Cabbage, Cauliflower and Lettuce: Cultivators' Leaflet No. 7.	Department of Agriculture, Burma.	Government Press, Burma, Rangoon.
69	Turnip and Khat Rabi or Knol Khol: Cultivators' Leaflet No. 8.	Ditto.	Ditto.
70	Carrot, Radish, Beet and Parsnip: Cultivators' Leaflet No. 9.	Ditto.	Ditto.
71	Peas, Broad Beans and French Beans: Cultivators' Leaflet No. 10.	Ditto.	Ditto.
72	Onions and Leeks: Cultivators' Leaflet No. 11.	Ditto.	Ditto.
73	Tobacco Cultivation: Cultivators' Leaflet No. 12.	Ditto.	Ditto.
74	Cultivation of Maize: Cultivators' Leaflet No. 13.	Ditto.	Ditto.
75	Cultivation of Cotton: Cultivators' Leaflet No. 14.	Ditto.	Ditto.
76	Cultivation of Jute: Cultivators' Leaflet No. 15.	Ditto.	Ditto.
77	Report on the Operation of the Department of Agriculture, Burma. Price 4 annas.	Ditto.	Ditto.
	Agricultural Chemistry.		
78	Sugarcane at the Partabgarh Experiment Station. Bulletin No. 13 of the Agri. Research Institute, Pusa. Price 4 annas.	G. Clarke, F.I.C., Agricultural Chemist, United Provinces and Khan Bahadur S. M. Hadi, M.R.A.C., M.R.A.S., Assistant Director of Agriculture, United Provinces.	Government Printing, India, Calcutta.
79	Annual Report of the Agricultural Chemist to the Government of Mysore for the year 1906-07.	A. Lehmann, M.A., B.S.A., Ph.D., Agricultural Chemist to the Government of Mysore.	Mysore Government Central Press, Bangalore.
	Mycology.		
80	The Haustorium of Cansjera Rheedii. Memoirs of the Department of Agriculture in India. Botanical Series, Vol. II, No. 5. Price Rs. 2-8.	C. A. Barber, M.A., F.L.S., D.Sc., Government Botanist, Madras.	Messrs. Thacker, Spink & Co., Calcutta.
81	On Flax Dodder. Bulletin No. 11 of the Agricultural Research Institute, Pusa. Price 4 annas.	A. Howard, M.A., A.R.C.S., F.C.S., F.L.S., Imperial Economic Botanist.	Government Printing, India, Calcutta.
	Economic Botany.		
82	The Making and Care of Lawns in India. Bulletin No. 12 of the Agricutural Research Institute, Pusa. Price 4 annas.	A. Howard, M.A., A.R.C.S., F.C.S., F.L.S., Imperial Economic Botanist.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*concld.*

No.	Title.	Author.	Where published.
		Economic Botany—concld.	
83	The Milling and Baking qualities of Indian Wheats. Bulletin No. 14 of the Agricultural Research Institute, Pusa. Price 4 annas.	A. Howard, M.A., A.R.C.S., F.C.S., F.L.S., Imperial Economic Botanist, and Gabrielle L. C. Howard, M.A., Associate and late Fellow of Newham College, Cambridge.	Government Printing, India, Calcutta.
84	The Races of Jute, *Agricultural Ledger* No. 6 of 1907. Price 12 annas.	J. H. Burkill, M.A., Reporter on Economic Products to the Government of India and R. S. Finlow, B.SC., Fibre Expert to the Government of Eastern Bengal and Assam.	Ditto.
		Entomology.	
85	Annual Report on the Entomological Work conducted in the district during 1907-08. Price 5 annas.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
86	Locust in India. Bulletin No. 32 of the Bombay Department of Agriculture. Price 8 annas.	H. M. Lefroy, M.A., F.E.S., F.Z.S., Imperial Entomologist.	Ditto.
87	Notes on some Insect Pests. Bulletin No. 17 of the Department of Agriculture, E. B. and Assam. (Revised Edition). Price 1 anna.	Department of Agriculture, Eastern Bengal and Assam.	Eastern Bengal and Assam Government Press, Shillong.

VOL. IV, PART I. QUARTERLY. *JANUARY*, 1909

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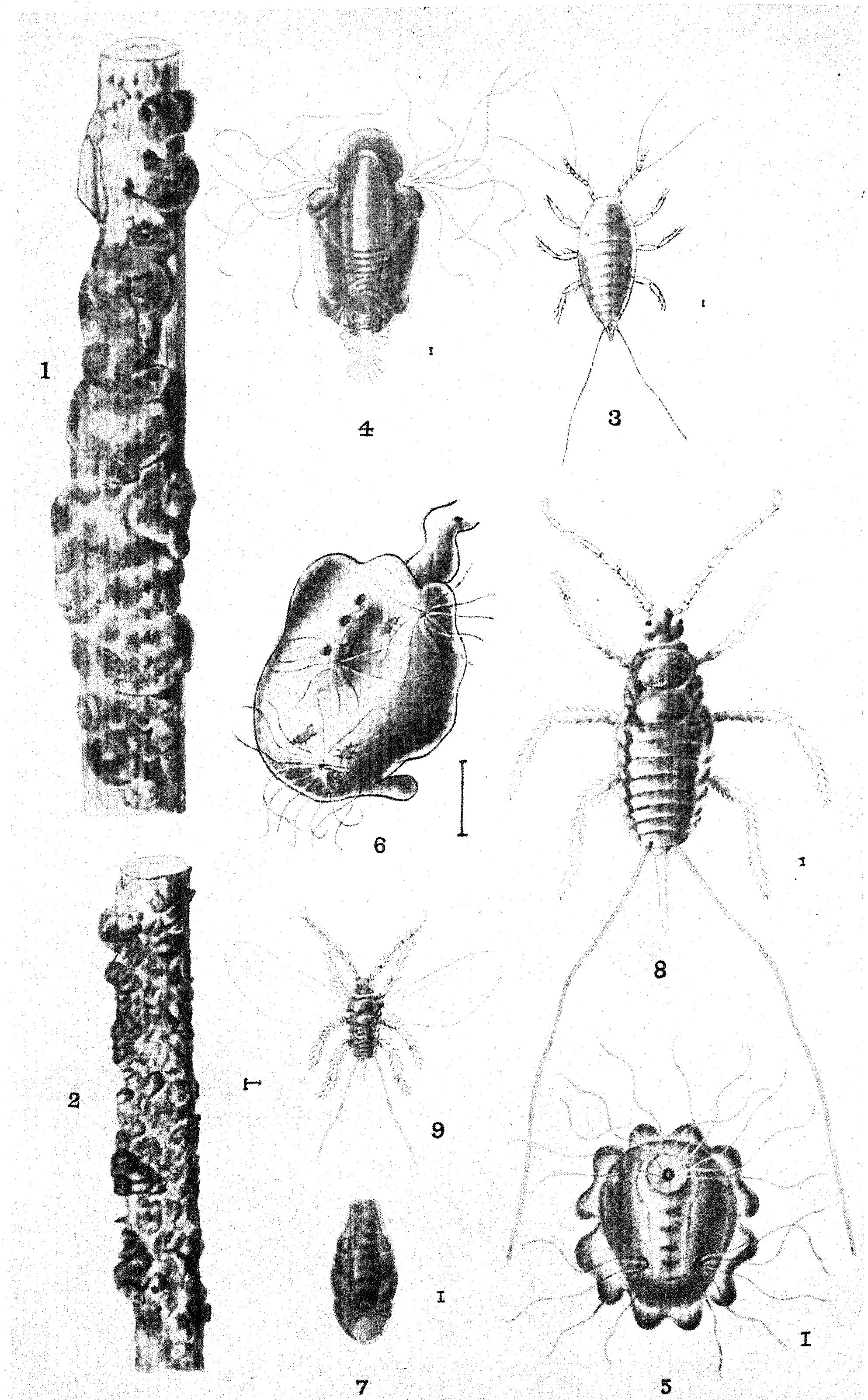

TACHARDIA LACCA.

(Engraved and Printed by) THE CALCUTTA PHOTOTYPE Co.

PLATE XXIV.—TACHARDIA LACCA

LAC.

Fig. 1. Healthy insects on stick.
„ 2. Unhealthy „ „
„ 3. First instar, active stage. x 40.
„ 4. Female, 4 weeks after inoculation. x 35.
„ 5. „ 13 „ „ x 15.
„ 6. Dead female cell, with young emerging. x 4.
„ 7. Male cell, 13 weeks after inoculation. x 15.
„ 8. Wingless male. x 12.
„ 9. Winged male. x 40.

(*See* page 260.)

THE FURLOUGH WANDERINGS OF A DIRECTOR OF AGRICULTURE.*

By J. MacKENNA, M.A., I.C.S.,

Director of Agriculture, Burma.

II. Cambridge.

In my first article I dealt with the only place in Great Britain, with which I am acquainted, where the work is limited, strictly to research—untrammelled and unfettered by the superimposition of teaching. That this is the ideal situation, there can be no doubt; but financial considerations render it quite impossible in most cases to tell off one section for research and another for instruction. In most places in Great Britain, as in India, one man has to perform both functions—that of a Research Officer and that of a teacher. In Germany this is not so; but there seems to be in Germany not only more money but more men for scientific investigation and instruction.

Of those institutions visited by me which combine the two classes of work, pride of place must be given to the oldest established University, which has interested itself in agricultural science. With the rapid expansion of interest in agricultural science it was only to be expected that the ancient University of Cambridge, which has always been in the forefront of scientific progress, should put its house in order in this respect, and so, although it is a matter of comparatively recent growth, we now find at Cambridge a fully equipped Agricultural Department.

It is but fitting that the English University which, more than any other, has been the home of science, should thus encourage the most practical of all the sciences and that which so much depends on a knowledge of all the natural sciences.

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* Continued from Vol. IV, Part I, p. 15.

The visitor to Cambridge who asks for the "College of Agriculture" will probably never find it. There are no massive piles with domes and canopies to mark the home of agricultural science. They are very modest in Cambridge. I traversed numerous dark and subterranean passages at the University Chemical Laboratories to find myself in Professor T. H. Middleton's room—a dim and dismal sanctuary—with his colleague and successor—T. B. Wood's—hard by. Where R. H. Biffen the Botanist laboured, I never discovered, and the only regret of my visit to this ancient seat of learning was that I did not meet with this distinguished botanist whose Mendelian work on wheats is so well known. The *personnel* has changed since I was there. Professor Middleton has gone to the Board of Agriculture and has been succeeded by Professor T. B. Wood. The lecturer on agriculture is the portly and genial Mackenzie of Wye.

As I have remarked above, the agricultural work at Cambridge, as at most other Universities or Colleges in Great Britain, divides into two sections: teaching and experimental research. As a very large number of young Indian students now find their way to England to pursue their scientific studies, it may be of interest to outline the courses of instruction given at Cambridge.

The student of agricultural science at Cambridge can either obtain the degree of Bachelor of Arts or the University Diploma in agriculture. In the former case a residence of three years is required and the student must pass the previous examination in general knowledge. This may be taken and, generally, is passed before entering the University. It is then open to him to take either a general examination in literature, mathematics and science, or Part I of one of the regular Tripos examinations. If he is wise, he will take the latter course; and if he is well advised, he will select the Natural Science Tripos. In point of fact, this is the advice generally given by College tutors, who wisely insist on a general scientific training before the study of agriculture, pure and simple, is begun. The third stage is the special examination in agricultural science which

counts both for the degree of Bachelor of Arts and as Part I of the examination for the Diploma in Agricultural Science and Practice. Having obtained his degree of Bachelor of Arts, the candidate who has taken Part I of the examination in Agricultural science can proceed to take Part II of the special examination, and so qualify for the University diploma in Agricultural Science and Practice. In point of fact, for a student who proposes to take the degree of Bachelor of Arts, the courses can be made to overlap, so that one set of studies leads up to both qualifications. For a candidate, however, who merely wishes to take the Diploma in Agricultural Science and Practice no restrictions as to residence or other examinations are required. He has simply to pass Parts I and II of the special examination in Agricultural Science. The course is a two years' one; but if a student has taken Part I of the Natural Science Tripos with Botany, Chemistry and Geology as subjects, he can take the additional classes necessary for the Diploma in one year.

The Board of Agricultural Studies lay great stress on the importance of taking at least Part I of the Natural Science Tripos and strongly recommend students who aspire to appointments to take Part II also, which gives them the degree of Bachelor of Arts. This advice is, I think, absolutely sound. The better the general scientific training (I would almost add literary training also), on which agricultural science is based, the more accurate and wider will be the outlook of the student who has enjoyed these advantages.

Students reading for the Diploma in Agriculture may either join the University or not as they prefer. In the former case they will, in all likelihood, attach themselves to a particular College and, if they reside in College, they will enjoy those social and other advantages which residence in a College is supposed to confer. If, however, they elect to be non-collegiate or not to join the University, they will live in lodgings in the town and make their own arrangements. The latter is certainly the cheaper course; but for students from India the experience which College-life must give, is well worth the extra expense involved.

I have dwelt on the educational side of Cambridge at some length, because the subject is likely to prove of interest to Indian youths who are contemplating a course of study in England. I would strongly recommend such to take the Natural Science Tripos as well as the Diploma, and, if they can possibly afford it, to live in College. It is not only by its lecture rooms that an University educates. There are lessons learnt which do not form the subject of examination papers; but all of which go to the formation of character and to the equipment necessary for the battle of life. The East has much to teach the West as the West has much to teach the East, and I can imagine no better experience for all concerned than the interchange of views between English and Indian students engaged on the same studies which must result from in-College life.

The second aspect of the work at Cambridge is experimental research; and, although the School of Agriculture is a thing of very recent growth, a great amount of first class work has already been done. A very marked feature of this experimental work is the close contact which the Department of Agriculture already has with land-owners and tenant farmers. Thus, while the main field research work of the Department is done at Burgoyne's (University) Farm at Impington, a large number of useful experiments are also conducted under the supervision of the Department at various centres in the Eastern Counties on land placed at the disposal of the department by private farmers. These are, practically, small demonstration plots; but, whereas in India, Government generally must equip and maintain these, the position of Agriculture in Great Britain is such that enlightened farmers will willingly lend their land and share in the conduct of experiments. This is a system which we should soon be able to apply in India, and I have no fears of being able to obtain an equally willing response from the Indian farmer.

It is a pleasant walk of some five miles from Cambridge to Burgoyne's (University) Farm at Impington, and there I was met by Professor Middleton, who had come out by train. He explained that the farm was leased; the necessary capital to

work and equip the farm being raised by subscription. The conditions of lease are peculiar. The farm was in very poor condition when entered on by the Department. It is let on the understanding that no rent shall be paid for the first nine years, but that the land shall be brought into good condition. There are some minor conditions attached to the lease, and the Department has the option of leasing the farm, on a rental, for 10 years after the expiry of the present lease.

The area of the farm is about 140 acres. The soil is light to medium; burns quickly in dry weather and becomes very sticky—like so many of our Indian soils—after rain.

From a scientific point of view the most important piece of work being done at the farm is Biffen's work on wheat and barley. Unfortunately we had not the advantage of an explanation of the work by Biffen himself, but a very full account is given in his paper "Mendel's Laws of Inheritance and Wheat-breeding" in the *Journal of Agricultural Science* (Volume I, Part I), for January 1905. The main problem which he is attacking, is to obtain a "strong" English wheat, which will satisfy the English miller. In the article referred to, he remarks that the necessity of such work may not be evident to all. "The fact," he writes, "is generally recognised that the wheats of this country are characterised by the high yields per acre and by the shapeliness of their grain. We can grow on the average over 30 bushels to the acre, where the United States grew 14, Russia 10, and the Argentine 7. Yet the acreage under wheat in this country has fallen from three and-a-half million acres in 1876 to one and-a-half million in 1903, and we now grow approximately only one-fifth of the wheat we consume. Further than this, there is good evidence to show that the quality of the grain now grown is inferior to that of 20 years ago. It has been sacrificed to yield and many of the better class varieties...........have been more or less driven out of the field by varieties...........which are capable of giving slightly larger crops of grain and straw. These inferior varieties have now to compete with wheat imported from Canada, the United States, Russia and other countries.

The seriousness of the position becomes evident when one finds English wheat selling at 28*s.* 6*d.* a quarter when Manitoba Hard is selling at 33.

On searching for the reasons of this, the miller tells us that English wheat even of the better class varieties is lacking in "strength." We have no single variety which can be compared in this respect with the best foreign wheats. By "strength" he means the capacity of the wheat to produce a large, well piled loaf. We learn also that English wheat to be utilised at all for bread-making purposes has to be mixed with a large percentage of these strong foreign wheats. The flour of English-grown wheat alone will not produce a loaf which is marketable under present conditions, and until the public taste demands dull and heavy bread, such wheat can only be used in "mixtures."

Biffen also points out a further complication. With the expansion of colonial export of wheat, flour mills have sprung up at the seaports where the hard grain obtained from the colonies is at once milled. Inland millers who require this hard grain to mix with the English wheat are handicapped by the extra cost of transport from the seaport to the inland town. "If, in order to compete with the port miller, he has to use still larger quantities of foreign grain to make up for the shortcomings of our own, their prices must fall still lower, or he will be driven out of the field, and with him will disappear the market for home-grown wheat. The whole question then pivots on the strength of the grain we can produce. Even a slight increase in quality would go a long way to improving the position both from the farmer's and miller's point of view, for it would immediately widen the market for the home product."

Such is the very definite and important economic problem which the Botanical Section at Cambridge have placed before themselves. The aim of the experiments is to discover a "hard" grain and the system followed is that of "cross-breeding" acting on the principles of Mendel's Law of Inheritance.

The experiments, which are conducted under a wire net house, commenced with the growing of some 200 different

varieties of wheat. Of these a large number were discarded after the first year, as having no marked characteristics or as being unsuitable to English conditions. Those with marked characteristics, for example, resistance to rust, good straw, heavy yield, were retained and crossed with wheats proved to be of a good milling quality. When I visited Impington, four generations of wheat hybrids were being grown. As soon as type characteristics are fixed, those hybrids which show a distinct superiority over English wheat are grown; and by a process of rigorous selection and rejection it is hoped that a "strong" wheat will ultimately be obtained which will meet the requirements of the English miller. The theory once proved, it is only a matter of the production of the seed in sufficient quantities to affect the whole crop of the country. There is any amount of work of this kind to be done in India and the Botanists of the Agricultural Service have a great field before them.

With barley and other cereals, the process is not yet so elaborate. The experiments are really purely varietal; that is to say, all available varieties are grown for comparative study and only the best are retained: the outturn and weight of the grain and the weight of the straw being all taken into account.

In this varietal work the assistance of private farmers has already been enlisted; the comparison, in such cases, being between the selected variety issued by the Department of Agriculture and the varieties generally cultivated by the gentlemen conducting the experiment. This is quite the most certain way of ensuring the adoption of a better variety on the farm where the experiment has been conducted.

While the work on the "cross-breeding" of wheat is, undoubtedly, the most important being done at Cambridge, there is a very thorough piece of work being carried out on the principal root crops which is full of interest, principally on account of the accuracy of the methods adopted; and the close inter-relation of the field and laboratory work. The root crops worked with are Swedes, Mangels, Turnips and Kohl Rabi. The first stage of the experiment is the growing of the varieties for comparison of yield

per acre. But in the case of root crops bulk is not everything. The food content of a root or its food value is an equally important factor; one may have a very large root which contains an enormous quantity of water and which will not have the food value of a much smaller root containing a larger quantity of dry matter. Accordingly a large number of roots are subjected to analysis in the chemical laboratory and, from a consideration of yield and food content taken together, the most profitable varieties can be selected. From these selected varieties seed for further trial is obtained, the ultimate object of the experiment being the obtaining by selection of improved varieties of roots. As bearing on this subject I would invite attention to a valuable paper on "Variation in the Chemical Composition of Mangels" by T. B. Wood and R. A. Bery, which will be found at page 176, Volume I, Part II of the *Journal of Agricultural Science.*

The mangel crop is the most important root crop of the Eastern Counties around Cambridge, and the Department of Agriculture has, therefore, devoted much attention to this crop. Experiments are varietal—to test the composition and yield of the different varieties on the market. Incidentally, as these experiments are carried on at private farms as well as on the University Farm, the variations due to change of locality can be noted. This is an important point which is probably not sufficiently taken into account. It has been particularly noted in the case of oats transferred from Scotland to the South of England.

Another valuable series of experiments is designed to show the effects of manures on the yield and composition of mangels, while a similar series is applied to the swede crop. The general conclusion would seem to be that manures have but little effect on the composition of mangels.

A point of considerable scientific interest to which my attention was drawn, was the effect of the size of a root on its composition. It has been found in the case of long red mangels, that as the size increases from 2 to 3 lbs., the dry matter decreases

·7 per cent.; from 3 to 4 lbs. ·6 per cent.; from 4 to 5 lbs. ·4 per cent.; from 5 to 6 lbs. ·3 per cent.; and from 6 to 7 lbs. ·2 per cent. Similar enquiries on the root crops of India would be interesting.

A large amount of work has also been done on the potato crop, and some of the results are highly interesting. In the varietal tests for yield which extended over a series of years the best results were obtained in the first year, 1902, from "Dobbie's Factor," obtained from Scotland. In the second year, 1903, the produce of the 1902 crop was again planted. "Dobbie's Factor" still held the lead amongst the old stock with a total outturn of 12 tons 12 cwt. and 14 tons 8 cwt., but was eclipsed by a new strain introduced for the first time—"Findlay's Evergood" from Lincolnshire—which yielded 13 tons 19 cwt. and 14 tons 16 cwt. New seed of "Dobbie's Factor" was also obtained this year, some from Lincolnshire and some from Scotland. These came second and third with outturns of 11 tons 17 cwt. and 12 tons 19 cwt. in the case of the seed from Lincolnshire and 11 tons 9 cwt. and 12 tons 16 cwt. in the case of the seed from Scotland. When seed from the original crop of 1902 was planted for the third time in 1904, it was found that Findlay's "British Queen" which had been fifth on the list in 1902, with a yield of 6 tons 9 cwt., now headed the list with an outturn of 12 tons 6 cwt., while "Dobbie's Factor" had fallen into the second place with 11 tons 2 cwt. In the case of seed taken from the 1903 crop and planted for the second time in 1904 there was a general improvement in outturn, which may, to an extent, have been due to the varying conditions of the season.

In addition to varietal tests the effects of cutting "sets"; a comparison between large and small "sets"; "sets" stored in pits and "sets" stored in potato boxes; and the usual manurial experiments indicate the lines of work being done on this crop.

The rotation experiment at Burgoyne's Farm had not reached a stage, when I visited Cambridge, at which any definite conclusions could be drawn. The object of the experiment is "to ascertain at what time it is best to apply phosphates and potash

to crops grown in a four-course rotation. Manures containing phosphates and potash are applied chiefly to assist roots and clover. The main question here is: Do such manures when applied to the root crop satisfy the requirements of the following clover crop?"

A considerable area of the farm has been laid down to permanent pasture, which is divided into sections to permit of the comparison of various systems of manurial treatment. No definite results had been obtained at the time of my visit.

I had not an opportunity of seeing the work done on private farms, or on the Experimental Farms of the East Suffolk County Council, which are controlled by the University Department. As I have said above, the close relationship which exists between the Department and the private farmer is one of the principal and most gratifying features of the Cambridge work; while all their experiments suggest the scientific atmosphere which seems inseparable from Cambridge.

A most enjoyable day ended in the Senior Common Room of St. John's College where, in the mellowed light of antique silver candlesticks one discussed old Indian experiences with Professor Middleton, whose recollections of his seven years in Banda are still fresh; talked of Burma and the Burmans to Dr. Scott—then Bursar and now Master of the College, whose interest in Burma is a fraternal one; and discussed various geological problems with the veteran, Dr. Bonney, till such time as "gates closed" loomed near, and we set forth for our respective abodes lest, peradventure, the Proctor should catch us unawares.

(*To be continued.*)

THE ADVANTAGES OF IRRIGATION WHEN THE SUPPLY AVAILABLE IS USED FOR RABI OR COLD WEATHER IRRIGATION.

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In a country, where there is no rain, the advantages of irrigation are clear to everyone, for no crops can be grown without irrigation, all crops are entirely dependent upon the water from the canals, and require water at regular and suitable intervals for their proper growth ; but in countries where the rainfall is scanty and precarious, irrigation is even of greater value and more far-reaching in its effects, for the water is needed to supplement the supply obtained from the rainfall, the canals have not to provide the whole of the water for the growth of the crops, and the volume available can bring a far larger area of crop to maturity than when the entire water supply for the crops has to be provided.

The greater part of Central India, and in particular the Deccan, consists of tracts where the benefits to be derived from irrigation are immense. The fields are in ordinary course cultivated and prepared for the growth of crops if the natural rainfall comes, but the arrival of the rain is uncertain, and until the ground has been sufficiently welted to provide moisture for the germination of seed, many cultivators of scanty means, to whom the loss of the seed is a serious matter, refrain from sowing their fields. When the rain does fall in sufficient quantities and the sowing of seed would no longer be a risk, it often happens that the rain is heavy and continuous, rendering the surface of the ground unfit for sowing operations, and cultivators are unable to get into the ground the seed of crops they intend to grow ; as the

rainy season is of limited duration, the time for the growth of the crops is materially shortened, and may easily become insufficient and poor crops result. Now, when a supply of water is available from a canal for irrigation, the time of sowing is no longer fixed by the precarious rainfall, but the cultivators may choose the time they deem most suitable from their long experience, can obtain water from the canal to prepare their field for sowing and can get the seed into the ground at the best time of year. Again, if rain falls, at the beginning of the season, only just sufficient in quantity for the production of a surface on the fields suitable for sowing, the cultivators may get their seed in at once without anxiety as to the result, for if further rain does not come as required, water can be obtained from the canals to ensure the growth of the crop. In the matter of sowing at a suitable period of the year, the presence of a canal, with a reliable water-supply, has an effect on the cultivation and prosperity of a district far in excess of the actual irrigating capacity of the canal. It may happen in some years that the canal is not required to irrigate the monsoon crops at all, but that the prompt sowing has enabled the cultivators to obtain far better crops than their neighbours, who have to work without the resources of a canal to fall back on.

It is, however, in supplementing the rainfall that the canals give the greatest benefit to the land commanded. The rainfall is frequently, and in the Deccan districts, usually, either insufficient, or falls at intervals too far apart for the proper growth of the crop ; the report " crops withering " is one only too familiar to District Officers in India, and at such periods crops can be saved by one or two waterings. The actual amount of water required to mature a cereal crop is not great ; careful experiments in India have shown that a total depth of 12 inches to 14 inches delivered on to the field, by waterings at suitable intervals, is sufficient to mature a cereal crop ; and in the Eastern counties of England where excellent crops of cereals are grown, the total average for the whole 12 months is 25 inches only ; and in years when the rainfall is considerably below the average, excellent crops are

obtained, and yet much of the rain does not fall whilst the crop is in the ground. Tracts of similar rainfall in India produce excellent cereal crops; for instance, the rainfall in the Eastern Deccan where jowari or great millet is grown as a *rabi* crop is frequently under 18 inches for the period of growth of the crop, but if suitably distributed is sufficient.

If, therefore, some 8 inches of rain have fallen and crops have started well, then a single watering from a canal followed later by a slight rainfall, or by a second watering, is sufficient to produce excellent cereal crops.

In actual practice in India these conditions occur frequently in the middle of the monsoon or summer crop, and at the end of the *rabi* or cold weather crop.

Fields are sown after the early burst of the monsoon and then a long break comes during which a watering is required, or the crops would wither, and then the autumn rains come and provide the moisture for the last stage of growth of the crop. The quality of the monsoon crop may be deteriorated by excessive autumn rain, but there will always be a crop and abundance of good fodder if helped by a canal.

It is for the cold weather or *rabi* crop, however, that irrigation is most appreciated and desired. Sufficient rain as a rule falls for the sowing, but the subsequent rains required to mature the crop are most precarious, and frequently fail. The quantity of rain required is not large, as at this season of the year dews are usually heavy, but if the rain does not fall, then the crop fails, or is seriously deficient. The difference in the outturn of a cereal crop that one watering can make when the *rabi* crops have started well, but are withering for want of more rain, often means three-quarters of the crop. These *rabi* crops are not liable to damage during harvest; at the end of the *rabi* season rains cease and the harvesting is, as a rule, uninterrupted by the weather. The *rabi* crop is thus the one for which irrigation is most desired, and for which it is most wanted.

Now, away from the rivers fed by the melting of snow on the hills there are few streams in India where any large volume

of water can be obtained during the *rabi*, or cold weather season, and, on the streams without snow-hills at their source, in order to ensure provision of water for *rabi* crops, it is usually necessary to store the water in tanks or reservoirs. Storage of water is always expensive, and the supply available and the capacity of the reservoir are, as a rule, less than required by the land to be irrigated, and the proper use of the stored water requires very careful consideration. In India with its wealth of sunshine, and freedom from frosts, most valuable crops can be grown if water is available the whole year round. Sugar-cane is one of the favourite crops for perennial irrigation, and the very high returns to be obtained from this and other twelve-months crops bring prosperity to the fortunate individuals who can obtain the water, and they are ready to pay apparently high prices for the perennial water, and to pay them regularly.

This regularity of demand and payment is a most important consideration in the working of a canal, and to the casual observer it appears much the best plan to encourage this valuable perennial irrigation, and to reserve the stored water specially for it; but though this brings great profit to a few, it grievously curtails the prosperity of the land as a whole under the canal, and seriously diminishes the money returns which can be obtained for the water.

When valuable perennial irrigation is undertaken under a canal, and the cultivators have not wells, or not sufficient wells, to irrigate the crop if the canal water fails, then the whole of the water stored must be reserved for the perennial irrigation, as the expense of this form of cultivation is great and the loss of a crop is a serious loss to the cultivator, and the area irrigated must be limited to the area which can certainly be supplied with water. In a canal devoted to perennial irrigation, the storage reservoir is therefore limited in size to that required to store the supply available in years of bad rainfall. The supply is about half only of that available in ordinary years, and although the bad years occur at long intervals, the dread of one occurring limits the area of perennial cultivation to that possible under the

assured supply, and further, the dread of a very late arrival of the monsoon rains make it necessary to keep a supply of water stored in the reservoir to meet the requirements of the perennial crops up to the latest arrival of the rains, and, as the rains almost always arrive much before the date, there is then a balance in the reservoir which is not used, and has to be run to waste down the river.

In a canal system devoted to perennial irrigation the reservoir therefore stores only half the normal supply of water, and is not able to use the whole of this diminished storage, but has to waste part of the costly water.

In addition to the waste of storage and river supply a canal devoted to perennial irrigation wastes, or neglects to utilise, almost the whole of the rainfall which falls upon the land commanded by the canal. Allowing for an ordinary rainy season, and ordinary deficiency of supply in the *rabi* season, a perennial crop will require some thirty heavy waterings from the canal throughout the year to bring it to maturity. Whilst a cereal crop like jowari or great millet, in ordinary years of deficient rain, seldom requires more than three waterings, and, as explained above, when the rain has been suitable at the sowing, or early part of the season, and fails at the end, then two waterings or even one is sufficient to produce good crops instead of failure. These two waterings sufficient for the canal crop are only $\frac{2}{30}$ of the requirements of a perennial crop, and hence if the water available be given to *rabi* crops, then the rainfall on all the area irrigated, at least 15 times the area of perennial, will be utilised; and two waterings from the canal will suffice to mature the crops; if on the other hand the water be withheld from the *rabi* crops and be reserved for perennial, then the only advantage obtained from the rainfall is the saving of one or two waterings on the perennial area, and all the rain on the far greater *rabi* area is lost and wasted and the *rabi* crops die. This area is more than 15 times as great as the perennial area; it is really over 20 times as great, for the losses incurred in storing water for the perennial crop during the hot weather will be avoided if the water be used during the cold

weather. During the hot months of the year, the loss in vertical depth by evaporation from the surface of water in a tank is more than twelve inches a month, and hence from every acre of water surface more water is lost during the hot weather than is required to irrigate an acre of perennial crop during the same period. Additional loss is also incurred during the distribution of water for the extra period, and in the hot weather.

This loss by distribution is not easy to determine accurately; there is the loss by evaporation from the water surface of the canals and channels, and from the width of ground kept damp by percolation and absorption, and there is the loss by direct percolation deep into the ground. Irrigation engineers are in general agreement, that, for ordinary systems of distribution where about one-third of the land commanded is irrigated, the loss is over one-half of the total supply issued from the reservoir.

The water which has to be reserved in the storage tank for the perennial irrigation during the hot weather is, therefore, in volume twice as much as is actually put on to the crops, but if it were used for *rabi* irrigation, almost the whole of it would be available for the cereal *rabi* crops, for the loss in distribution is already being incurred, and there will be but slight extra loss due to the extra volume distributed.

The water it is actually necessary to store for an acre of perennial crop is thus considerably more than sufficient for fifteen times the area of cereal crop in the *rabi* season. When the reservoir storage is devoted to perennial, the whole of the water cannot be effectively used, and only half the normal supply can be relied upon.

In order to avoid the heavy losses in distribution wherever perennial irrigation is practised, there is a tendency to concentrate the irrigation as near to the source of supply as possible and to mass the irrigated crop together. In the earlier stages of the life-history of a canal given up to perennial irrigation, this results in the water-logging of some of the land. It is exceedingly difficult to limit the quantity of water required for irrigation merely to the quantity required by the crop, and in order to induce the water

to flow over the ground a depth greater than the crop needs has to be applied, and the absorption of the soil whilst the water is flowing over it takes into the ground a greater volume of water than is required for the crop. This loss can be reduced by subdividing the fields into small plots, and providing numerous small distributing channels, in which there is less waste than when the water flows over a wide area; and if the surface of the ground is well tilled, and smoothed and made even, the quantity of water required is also reduced, but both these methods mean extra labour to the cultivator, and if he has no inducement to economise water, the question to him is merely one of expense, and he has to choose between paying for the extra labour of cultivating finely, and preparing his field for proper distribution of the water, or losing a little of the value of his crop by excess of watering. The profits from this class of crop are, however, so high that the cultivator naturally elects to devote his labour to the cultivation of as large an area of crops as he can obtain permission for from the Irrigation officer, and to overwater his crop.

The ground is thus saturated and the level of the subsoil water rises, and at the same time the irrigation from wells ceases, for the cost of lifting water from wells is so much greater than any water rate yet levied in India, that canal water is always taken in preference to lifting water from wells. Moreover, in a new canal the owners of wells have land prepared for irrigation, and are well off and more prosperous than their neighbours. and are in a better position to meet the expense of the high cultivation required for valuable perennial crops.

Hence, in the early stages of a canal given up to perennial irrigation, the irrigation is concentrated on the area of land nearest to the source of supply, the wells are no longer used, and the fields are overwatered, the subsoil water-level rises, and some lands are water-logged.

In ordinary gardens watered by irrigation from wells only water-logging is not met with; the costly water lifted from the well is distributed with care, and less depth is placed upon the land; the land irrigated is all in the neighbourhood of the well

as the supply obtained is not sufficient to travel far, and the loss in a long channel would be excessive and serious, and the fields are therefore necessarily within the effective drainage care of the well; and the excess of water used in irrigating the field is free to percolate through the ground to the well to be used again. There is this very great difference between garden cultivation from wells and perennial cultivation from a canal; in the former, or garden cultivation, the work of irrigation at the same time drains the land, for the water for irrigation is abstracted from the subsoil water of the fields irrigated, whilst in the latter or canal irrigation, the excess water used is continually sinking into the ground and raising the level of the subsoil water, and either the fields themselves become saturated or, if there be good natural drainage, some lands in the neighbourhood where the drainage concentrates, become water-logged.

The benefits derived from perennial irrigation are so great that the damage to a few fields by water-logging is a comparatively small item in the expense of cultivation, but still it is desirable to get rid of the damage and also to avoid the waste of water, and the way to do this is to sink wells and lower the subsoil water by using it for irrigation. It may seem paradoxical that the remedy for water-logging is increased irrigation, until it is realised that the increase of irrigation is not obtained by adding more water from the canal, but by removing from the ground by means of wells the excess water which has been poured upon the ground from the canal; when this point is understood, that the well is taking water out of the ground and lowering the level of the subsoil water, then it will be clear that the irrigation from the well is also draining the ground; as all the water applied to the surface of a field for irrigation does not sink into the ground, and the crops do consume some water and much is evaporated. If irrigation from wells be combined with canal irrigation, it is possible to irrigate far larger areas than by the canal water alone, and if the wells are used sufficiently, it is possible to arrive at a state of equilibrium when the water withdrawn from the soil is equal to the excess percolating

downwards from canal irrigation, and the level of the subsoil water will remain steady.

It is clear that this desirable result cannot be obtained without the hearty co-operation of the cultivator, and the co-operation can be secured, and the wasteful losses and neglect of part of the available supply of water can be avoided, by working the canal as a *rabi* canal, and giving preference to the *rabi* or cold weather crop, instead of to the perennial crop. In a canal system where first preference is given to *rabi* irrigation the area ordinarily irrigated will be that possible by the supply of water obtained in normal years; for these crops are annual, the sowing of them can be limited to suit the amount of water known to be available, and as the supply is obtained during the monsoon, before the *rabi* crops are sown, the quantity available is known before seed is sown for *rabi*. The reservoirs may then be made large enough to store the supply obtainable in normal years, or twice as much as the volume available in bad years; and the whole of the supply can be utilised and the reservoir completely emptied. The canal may be laid out to irrigate an area twenty times as great as the corresponding perennial canal could irrigate, and crops can be assured on the area in all except the very exceptional years, which occur in the Deccan about once in 20 or 30 years, and even then a large proportion of the area can be irrigated if the canal has a supply from the Western Ghaut or some similar range of hills where the rain never entirely fails.

In the few and exceptional years when the rainfall is good and timely, irrigation is not wanted, but in the Deccan these years are exceptional, and as a rule irrigation is required at some period of growth.

If the applications for permission to irrigate have to be made annually, the cultivators naturally wait until the character of the *rabi* rains has been determined, and if the rains are good water is not applied for, and is not paid for, and if the rains are good at the beginning and a failure at the close, there is a rush for water, all crops requiring it at once, which the canal cannot

meet, and there is not the regularity and certainty of payment for water that is so convenient for the management of a canal.

If payment were made by the volume of water issued, there would be still greater variation, as the demand may be for one watering only, or for watering for the complete season according to the character of the rains, and the endeavours to work a Deccan canal either by payment for area irrigated, or by volume of water issued, have resulted in great variation of revenue from the canal, whilst the cultivators have continually had good crops. As the cultivators were much too sensible to spoil their *rabi* crops by watering them when they did not want it, then, because they did not regularly take the water, it has been given to cultivators of perennial crops who would take it regularly. When once given in this manner, it cannot be taken away again and given back to the *rabi* cultivators, and so the rabi cultivation fell back to its former uncertainty and failure, and to the state it was before the canal was constructed.

Now, if opportunity be given to the *rabi* cultivators to assure themselves and their crops of a supply of water if required, by taking long leases, they will gladly avail themselves of the privilege; the cultivators should not be obliged to take water and so spoil their crops when good rains have supplied them, and hence the payment by the cultivator should be on the area of crops grown. The rôle of a canal devoted to *rabi* is to ensure crops; though the amount of help required from the canal will vary considerably, the cultivator will always have a good crop to pay the canal rates: provided that the rates are levied only on the area on which crops are matured.

This is the plan followed on canals in tracts where there is no rainfall, as in Sind; in such districts water rates are levied on the area of crop grown, remissions being made when crops are poor and fail, and the same system is the best for land under a *rabi* canal.

The regular growth of *rabi* crops under a canal will encourage perennial irrigation from wells, for when the rainfall is deficient, the irrigation by the canal makes up for the shortage and the

subsoil will obtain the excess water used for irrigation of the *rabi*, and the wells will always have a good supply; in fact, the wells become independent of the rainfall. Wherever wells are constructed, perennial crops may be safely cultivated up to the capacity of the wells for irrigation. The cultivation of perennial crops on these wells in an area served by a canal for *rabi* crops is much less expensive than in a garden served by a well alone, for the labour of lifting the water is very much reduced. During the whole time the canal is running, or for about eight months of the year, it is not necessary, as a rule, to use the wells at all, for the water from the canal can be used for irrigation, and during the remaining four months of the year, the amount of labour for lifting will vary. If the *rabi* rains have been good, and water not issued from the reservoir for the *rabi* crops, then a supply may be available for the whole of the four hot months of the year, and no lifting at all may be required, but as a rule the wells must be worked from one month to three months of the hot weather. In this manner perennial crops are obtained with the labour of lifting water for a few months in the hot weather only, instead of during the whole twelve months, and the land also is drained and the subsoil water kept low.

It will be understood that the subsoil water will rise a little during the monsoon and cold weather, or *rabi* season, whilst crops are being watered, and be lowered during the hot weather only, and hence wells under a *rabi* canal have this further advantage over garden wells, that the underground storage is drawn upon for two and three months only of the year, instead of for the whole twelve months, and hence can be relied on to give a larger supply of water, and irrigate greater areas than an ordinary well in a garden.

Hence a canal devoted to *rabi* at the same time encourages perennial irrigation from wells, and makes it possible to irrigate a larger area of these valuable crops by the help of wells in the hot weather, and the hearty co-operation of the cultivator in working wells, with all the advantages of drainage of the subsoil, and of perennial irrigation is secured.

Now, the condition above described of a canal devoted to *rabi* irrigation and growing perennial crops by the help of wells is not an imaginary one, but is the actual practice and method of management of all the old irrigation works, and may be seen to great advantage in the Bandhara irrigation of Nasik and Khandesh, and in the tank irrigation of the Southern Mahratta country and many parts of India. The canals are small, but they are numerous, and the areas irrigated total to many thousands of acres. The lands under these small works are laid out for monsoon and *rabi* cultivation, and wells are an essential part of each garden, and are used to supplement the scanty hot weather supply. The value of the monsoon and *rabi* irrigation for strengthening the supply to the wells is fully understood. The monsoon and *rabi* irrigation is also massed together, so that the losses in distribution are much reduced, and the water used to the greatest advantage. In many cases the cultivators combine and mass crops of the same character together, and reduce the cost of watching and protecting the crops, and also enable better cultivation to be adopted. There are no water-logged fields in these old works.

Villages with such irrigation are always prosperous; water for drinking is ample for man and beast, fodder is always abundant, and the cattle well fed, crops are assured, vegetables, condiments and spices are grown, fuel is cheap and plentiful, as trees grow well on the boundaries of the fields; the mango, tamarind and other fruit trees grow luxuriantly, and fruit is plentiful, and shade and shelter are provided by the trees for men and cattle. The villages are havens of rest and comfort, and their fortunate occupants are envied by their neighbours and visitors, who are without the advantage of irrigation.

The abundance of fodder is of the very greatest value. In all the famines so prevalent in India, the maintenance of the lives of human beings is much more easily provided for than the protection of the cattle. For men, grain only has to be carried, but for cattle fodder is necessary, and the carriage of large bulky supplies of fodder from great distances is most costly and difficult.

The very great value of an abundant fodder supply on irrigation works is not adequately recognised. Without the cattle, the lands cannot be properly ploughed and cultivated, or produce carried to market, and the value of cattle is not limited to the work done by them, but the manure produced is also required for the treatment of the land.

Wherever fodder is abundant, there is no famine, the cattle are strong and healthy, and the land well tilled and ready to use to the very best advantage all rain that may fall, and the district is maintained in a high state of prosperity. On the other hand, if there be no fodder, the cattle die, are not available when rain does come, and there is difficulty in preparing fields for cultivation and the famine is prolonged. Moreover, it is not easy to replace cattle when the majority of those in the district have died, and the effects of a great loss of cattle are felt for a number of years, until young stock have grown up to replace the loss. There are many streams in India where the supplies, if stored, would usually be sufficient for large areas of *rabi* irrigation, though at times they would fail for perennial irrigation, and where, if irrigation works were constructed and worked as *rabi* canals in the manner described in this note, permanent prosperity could be brought to large areas now liable to frequent failure from precarious rainfall. Such works would pay handsome dividends, if they shared in all the benefits they confer.

They must be designed to distribute the water proportionally and equally to the area commanded; and the area must be limited to that which can be saved by economically combining the water available for irrigation with the rainfall on the land. The cultivators must be free to use as they wish the water allotted to their area of land, taking water when they require it, and not using it when the rainfall is sufficient for their crops, and then at all times, whether they use canal water or not, the cultivators will have a good crop.

The canal will change the method of cultivation from a hazardous gamble on the chances of a precarious rainfall, to a methodical business-like management of the facilities for cultiva-

tion with a certain return. The canal must not be judged by the quantity of water used, or by the area irrigated, but by the general prosperity of the area secured ; and both cultivators and canal should share in the prosperity. Whether such canals will be constructed depends mainly on whether they can be made to pay a fair interest on the cost of construction, and also to pay the cost of maintenance. Whether they will pay depends on the manner in which canal rates are levied. If water rates are paid on the area irrigated annually or on the water issued annually, then, unless very high charges are made in times of drought and scarcity, the canals would be worked at a loss, and if it be clear that canals will be worked at a loss, there is small chance of their being made.

But cultivators in these districts of precarious rainfall are keenly desirous of the benefits and help of such *rabi* canals, and will very willingly pay for them if allowed to do so, and if the canals share along with the cultivators in the benefits they have conferred, and a canal rate is levied annually on all the crops brought to maturity in the tract served by the canals, a moderate rate, easily paid, will be sufficient to make the canals profitable. This payment will not be on the area of land commanded, but on the area of crops grown and matured in that area, so that the means of payment will always exist, and there need be no arrears. There is a great future for canals in Central India and the Deccan if worked on this system, *rabi* areas twenty times as great as the area possible if the water were devoted to perennial irrigation can be irrigated, and at the same time perennial irrigation under wells will be encouraged. and the area of perennial thus possible will be at least as great as the area of perennial to be obtained by devoting the storage entirely to that class of crop. The country generally, therefore, benefits by the whole area of *rabi* crops obtained. Under a perennial canal the *rabi* crops are abandoned and lost, but under a *rabi* canal the greatest area of *rabi* possible is obtained, under canal irrigation, and also the perennial crops in addition, by the help of wells. The canal rate to be obtained from 20 acres of *rabi* is more than can be obtained

from one acre of perennial irrigation, and both canals and the country profit by the wider distribution of the water in a *rabi* canal, and though the gains of a few individuals will be less than under a perennial canal, the total gains will be greater, and more evenly distributed and, many more people will be made prosperous.

Irrigation should be so directed as to use to the greatest advantage the supplies of water available both from the streams and from the rainfall, and the *rabi* canals are able to use both to the full extent of the storage reservoirs practicable.

THE FIFTH MEETING OF THE BOARD OF AGRICULTURE.

By F. M. HOWLETT, B.A., F.E.S.,

Secretary to the Board.

THE fifth meeting of the Board of Agriculture was held this year at Nagpur from the 15th to the 20th of February; Mr. J. Mollison, Inspector-General of Agriculture in India, was President, and the number of those who attended was forty-four as compared with fifty-one at the meeting in 1908, the decrease being in accordance with the resolution passed last year to limit the number of members to thirty-eight. On this occasion there were eight Imperial and twenty-five Provincial members; Mr. Noël-Paton and Mr. Burkill also attended, and there were eight visitors. The Hon'ble the Chief Commissioner was present on one day, and it is not too much to say that the speech which he contributed to the discussion on methods of getting in touch with the cultivators was listened to with very real pleasure and profit by every man present. He is the first Governor of a province whose interest in Agriculture has carried him so far as to attend a meeting of the Board: we may hope he is not the last.

Viewed in the light of previous meetings, the one held at Nagpur was of considerable interest, as affording evidence of the evolution of the Department along natural lines of expansion and consolidation. Five meetings have now been held, and perhaps the present occasion is a suitable one for briefly comparing some of the subjects discussed at these meetings, and thereby getting a partial view, in some sort of perspective, of the work which the Department is carrying on. That this view can only be very incomplete is due to the fact that I omit

altogether one constant feature of every Board meeting, the Programmes of the Imperial and Provincial Departments and of the Native States, as I have neither the ability nor experience necessary for their proper consideration. The careful criticism and, if necessary, amendment of these programmes constitutes no small part of the Board's work, and it is to the programmes themselves that we must look for a detailed account of the methods whereby the aims of the Department are being furthered in each particular Province. It is largely in the programmes too that we shall find the record of that continuous spade-work and constant effort at adaptation to environment on which all progress must in the end be based. Nevertheless, from the other items on the agenda, we can get some idea of the stage of development which the Department has now attained.

The subjects for discussion at the first meeting, held at Pusa on January 6th, 1905, can be classed under five heads.

(1) The investigation, improvement, and extension of particular crops.

(2) Matters connected with methods of cultivation, buildings, and implements.

(3) Veterinary.

(4) Training and education.

(5) Co-ordination of work and general organisation.

This meeting of 1905 was in a sense prophetic, for practically all the subjects discussed by subsequent "Boards" fall into one or another of these same five divisions, though all the divisions are not represented on the agenda of every meeting. Taking division (1), we find that in 1905 the improvement and extension of the cultivation of cotton and jute were considered; in 1906 of wheat and tobacco; in 1907 of sugar-cane and cotton; and in 1908 of fibre crops in general, excluding cotton and jute. In each case the directions in which enquiry would be profitable were decided, and the work continues to be carried on along these lines, the methods adopted and results gained being indicated by the programmes and reports of the officers concerned. No special crop was considered at the 1909 meeting. Under divi

sion (2) were considered in 1905 Irrigation, in 1906 Commercial fertilisers, in 1907 Commercial fertilisers, the utilisation of River Silt, and standardising methods of soil-analysis, etc. There was no subject in this division on the agenda for 1908, but in 1909 the size most suitable for Experiment Farms and Demonstration-areas was considered. (3) Veterinary matters were discussed at the meetings of 1905, 1906 and 1907, and the improvement of Indian poultry in 1908. The subject did not figure on the programme for 1909, and the connexion between the Agricultural and Veterinary Departments is somewhat less close than might have been expected from the forecast of the 1905 meeting.

	(1) Consideration of particular Crops.	(2) Methods of cultivation, buildings, implements, etc.	(3) Veterinary.
1905 ...	Cotton and Jute ...	Irrigation	General Veterinary.
1906 ...	Wheat and Tobacco ...	Commercial Fertilisers ..	General Veterinary.
1907 ...	Sugar-cane and Cotton ...	River Silt, Commercial Fertilisers, Standardising analytical methods.	General Veterinary.
1908 ...	Fibre-crops, excluding Cotton and Jute.	——	Poultry.
1909 ..	——	Results of experience regarding the most suitable size for Farms & Demonstration-areas.	

The two questions which confront a Department such as ours are, first, what is to be done, and, second, how to do it. Accordingly, we find that at the first three meetings general questions of crops, methods, and stock occupy a prominent position in the records of discussion. Only rather special branches, fibres and poultry, had a place on the programme for 1908, while in that of 1909 there was no subject in any of these three divisions, except the one relating to the most useful average size for farms and demonstration-areas. It might, at first sight, seem that these subjects were not receiving attention at the present time. This of course is very far from being the case. During the first three or four years, investigations in many different directions were started on what appeared to be the most promising lines. To ensure the most advantageous use of the energies of the

Department it was necessary that these lines should be determined by consultation between all the officers concerned : hence the appearance of these subjects for discussion by the Board. Once the aim and method of an enquiry had been decided upon in consultation, however, the need for discussion as a separate subject no longer existed, so that while enquiries into the extension or improvement of particular crops (including all those shown above and many more) continue to be actively carried on and extended in every part of the country, their progress is recorded in the reports and programmes of the officers responsible. Work in these directions is settling ; not into a groove, but so as to flow into and fill the lines of a foundation on which the work of future years may firmly rest.

In Division (4) Education, we find that in 1905 the Board was considering the training of Farm Overseers and the possibility of establishing classes for boys at some of the experimental farms. In 1906 a curriculum for the new agricultural colleges was drafted with the idea of fixing more or less the standard of teaching and the ground to be covered. In 1907 and 1908 educational matters remained rather in the background: the colleges were in several cases in course of construction, and we find only a mention of the provision and training of agricultural engineers (1907) and a discussion of the course of studies suitable for Indian officers whom it might be found necessary to send to Europe or America for advanced training in agriculture (1908). In 1909, however, educational questions were again well to the fore, this recrudescence being due to the awakening activity of the Agricultural Colleges. Courses of instruction are now being given in Madras, Bombay, the United Provinces and the Central Provinces, the Punjab College will open almost immediately, while the Bengal College is expected to open next year, and will admit students from Eastern Bengal and Assam, where, as in Burma, there is at present no college. The difficulties hitherto encountered have been due to the insufficiency of the teaching staff to deal with large numbers of students, the difficulty of keeping the subordinate teaching staff abreast of

the progress of agricultural practice in all parts of their Province, and difficulties due to the wide range of the curriculum drafted by the Board in 1906. One further difficulty has been that of determining the class of student which it is most desirable in the interests of agriculture to attract. This is, of course, a matter of fundamental importance, but its settlement must await the accumulation of further experience, that hitherto gained being too small to admit of the question being finally decided at present. The choice laid before the teachers of agriculture in the Provinces rests mainly between two alternatives : to train an agriculturist in science, or to train a science graduate in agriculture. If the raw material is to be an agriculturist, it is obvious that the educational process to which he is subjected will not be equally applicable for use on a man who has already graduated in science, and until some degree of unanimity on this point is reached, the nature of the teaching and arrangement of the course of instruction must either be worked out independently for each Province or must remain to some extent tentative. Although a Scientific Agriculturist and an Agricultural Scientist are possibly not dissimilar, they are not identical, and the uncertainty as to the class of men which the Provincial Colleges will produce has retarded any very precise definition of the nature of the higher training to be given at Pusa. It is, however, agreed that its aim shall be to produce men capable of carrying out specialised work in the Provinces ; the exact lines on which the training will proceed will be dependent on the particular investigations in progress at the time, since it is recognised that the main object of Pusa is research, and that the present Imperial staff is insufficient to carry on such research and at the same time to conduct students through a course of training which is unrelated thereto. A provisional Pusa syllabus has been drawn up, which is intended to hold good for the present until the Provincial colleges are in full swing and able to send students fully qualified to profit by post-graduate courses of a somewhat higher type. To deal with all educational questions which may arise in the future and generally to

co-ordinate the educational work, it was proposed (1909) that a permanent Committee should be established. The matter will be considered at the Pusa meeting in 1910. The training best fitted for managers of Agricultural stations was also discussed and recommendations made.

In Division (5) we have placed all matters connected with co-ordination of work and general organization. By this is meant the proper adjustment of relations—

(*a*) between the Cultivator and the Department;

(*b*) within the Department itself: internal organization;

(*c*) between the Department and the Public.

Education, which we have placed in a separate division, would really come under (*a*), for one of its chief aims is to provide men who will act as intermediates, more intimately linking up the untutored ryot at the periphery with the expert officer at the organizing and distributing centre.

A tabular statement roughly shows the line of progress of these subjects :—

	(*a*) Relations between Cultivator and Department.	Education.	(*b*) Internal organization.	(*c*) Relations between Department and the Public.
1905	How to bring Provincial officers into closer relations with cultivators.	Training of overseers. Farm-classes for boys proposed.	How to bring Imperial officers into closer relations with the Provinces.	Publications, Memoirs, Bulletins, and the Agricultural Journal of India.
1906	......	Standard Curriculum for Agricultural Colleges drafted.	......	......
1907	......	Training of Agricultural engineers.	......	......
1908	How best to get into touch with cultivators.	Course of studies for Indian officers sent to Europe or America for training.	Expansion of Entomology and Mycology. Future constitution of the Board.	.....
1909	How best to bring the proved results of experimental work to the notice of cultivators.	Training of Farm-managers. The most suitable type of student to attract. Difficulties met with. Training at Pusa. Permanant Education Committee.	Touring of officers outside their own Provinces. Transference of suitable methods, implements, and crops from one Province to another.	Utilization of the Press in disseminating the aims and methods of the Department.

As has already been pointed out, the Board programmes have shown a progressive dwindling of subjects in divisions (1), (2) and (3), as these subjects became more and more absorbed into the programmes of the Provincial and Imperial Departments. On the other hand, divisions (4) and (5) have of late claimed increasing attention.

It is this which seems to me to give us some indication of how far the Department has progressed along the path of development. The common yellow wasp of our bungalows affords a rough partial parallel. When the Queen wasps emerge from their dormant condition in the Spring, they at once build a single cell, and in this cell they set about rearing an assistant-wasp. When this assistant-wasp has reached the adult stage, the pair of them join forces in laying down a larger nest and training up within it a numerous brood. By modifications of food and treatment the young wasps thus reared may have their development influenced in pre-arranged directions so as specially to fit them for special duties. At long intervals a Queen is produced.

If we may with due respect regard our Official Chiefs as representing the Queens, then their staff of trained European and Indian officers would be the assistant-wasps. Together they have now organized the work of rearing the big brood. The cells or colleges are made, and their occupants are being supplied with the kind of food which appears most likely to result in a sound and vigorous growth of workers. In this matter the wasp has the advantage of "instinct," that concentrated essence of ancestral experience which tells it exactly what grub is most suitable for its maggots. The Department, unfortunately, cannot decide by instinct on a course of training, but will have to modify its methods in accordance with the experience it can get for itself. As with the wasps, special methods will be employed for special purposes, and future development will make for expansion and differentiation, division of labour in a co-operative body.

Reference to the table will show that with one exception all the subjects discussed this year fall under divisions (4) and (5), Education and Organization. We can accept the analogy of the

wasp's operations and look on agricultural education as being ready for expansion into a wider activity than ever before. If in Division (5), Organization, we look at section (a) we find that a full and valuable report on methods of reaching the cultivator has just been completed. In section (b) were discussed methods for facilitating intercourse between Province and Province, making for general increase in "permeability," not only by affording greater facilities for the transference of good implements crops, and the like, but by a free passage and circulation of good methods and new ideas. The Chief Commissioner in the speech already alluded to touched on the connexion between concentration and expansion, pointing out that methods of concentration were valuable only until results had been obtained, when they should give place to methods which would secure as soon as possible wide dissemination and utilisation of these results. This holds good not only for particular problems, but in a modified degree for the work of the department as a whole. When a caterpillar has absorbed and digested a certain amount of food, it begins to swell, its internal arrangements undergo some slight reorganization, the skin bursts, and it expands into a fresh stage, only to renew the process of feeding and to moult again later on. Divisions (1), (2), and (3) represent the "food" which is being absorbed, the facts which have now been assimilated and co-ordinated sufficiently to warrant expansion. Divisions (4) and (5) in their increasing importance give us the visible evidence of that expansion. In short we may look on the 1909 meeting as showing us the department in process of moulting.

I have hitherto left untouched one subject which came up for discussion before this meeting, and that too a subject which more clearly than any of the others indicates the expansive tendencies abovementioned,—relations with the Public and the Press. Advertisement in the ordinary sense of the word is not the only consequence of an increased publicity, nor is the ryot the only man who is interested in agriculture.

The wasp is concerned only with the rearing of its brood of young. Beyond providing them with suitable food it does little

except protect them from weather and from enemies. This it does by unceasing personal supervision and by isolating the little community as far as it can by hanging the nest on a thin stalk, so as to narrow the approaches available to unfriendly parasites, the *bannias* of the insect world. The Department is adopting precisely similar methods, except that it is using co-operative banks instead of a stalk. But while its primary work undoubtedly does lie in bettering the condition of agriculture by working through the cultivator, there remain other directions in which its possibilities seem not fully utilised. Leaving altogether out of account the officials of other departments whose work may from time to time be assisted, and taking only the great commercial and planting communities, there is little doubt that only a small proportion of their members realize that there is a Department which is not only competent to give real help with regard to many of their recurrent or occasional difficulties but is actually desirous of placing its special knowledge unreservedly at the disposal of all whom it may benefit. For spreading the realization of such an idea the ordinary type of official publication is not the most suitable. Probably the mere fact that it is an official publication handicaps it at the start. To attract, to interest, and to help the general public means also to build up a backing of public opinion and public understanding of the greatest value. To do this there is little doubt that our present publications are not altogether well adapted. Yellow is the hue which is commonly supposed to attract the man whose interests are commercial: might not a tinge of his favourite colour be allowed to suffuse some portion of our annual literary output?

If we cannot bring ourselves to take even one step on the downward path which leads to the level of the "Daily Mail," it might be possible to produce periodically something on a rather lower or at least different plane to that on which the Agricultural Journal stands. The Journal is an extremely valuable publication whose high standard should not be degraded, but at the same time there is no doubt that it is less suited to the commercial man than to the scientific student of agricultural

methods. A comparison with such journals as those of the Australian Departments of Agriculture throws into relief the difference between the two types. The Provincial journals constitute a step in the direction of the second. Both are valuable. Is there not now in India a community of agriculturally-interested business men large enough to justify the publication of results in some more homely and digestible form, even perhaps embellished with those fascinating advertisements which so greatly enhance the interest (and value) of all ordinary technical and trade journals?

Here the wasp simile fails, because our activities are two-sided while the wasp's are only one-sided. We might try another, and liken the Department to a lump of wax consciously trying to fit itself into a mould whose lower half is the soil and the cultivator, the upper half the public. It is steadily settling into the lower half; contact with the upper is as yet very imperfect, and the wax must either expand to meet it, or bring it nearer to itself, or do both or neither. Complete contact can never quite be achieved, because both halves will vary their shape in accordance with changes in their requirements and economic conditions. The question of how to get in touch with the cultivator has been most fully considered by the last two Boards. If development is to continue, if an attempt is to be made to fill the upper half of the mould as well as the lower, it cannot be long before the Board programme has as its main feature a discussion on "how to get in touch with the Business Man."

THE CULTIVATION OF SHELLAC AS AN AGRICULTURAL PRODUCT.

By H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.,

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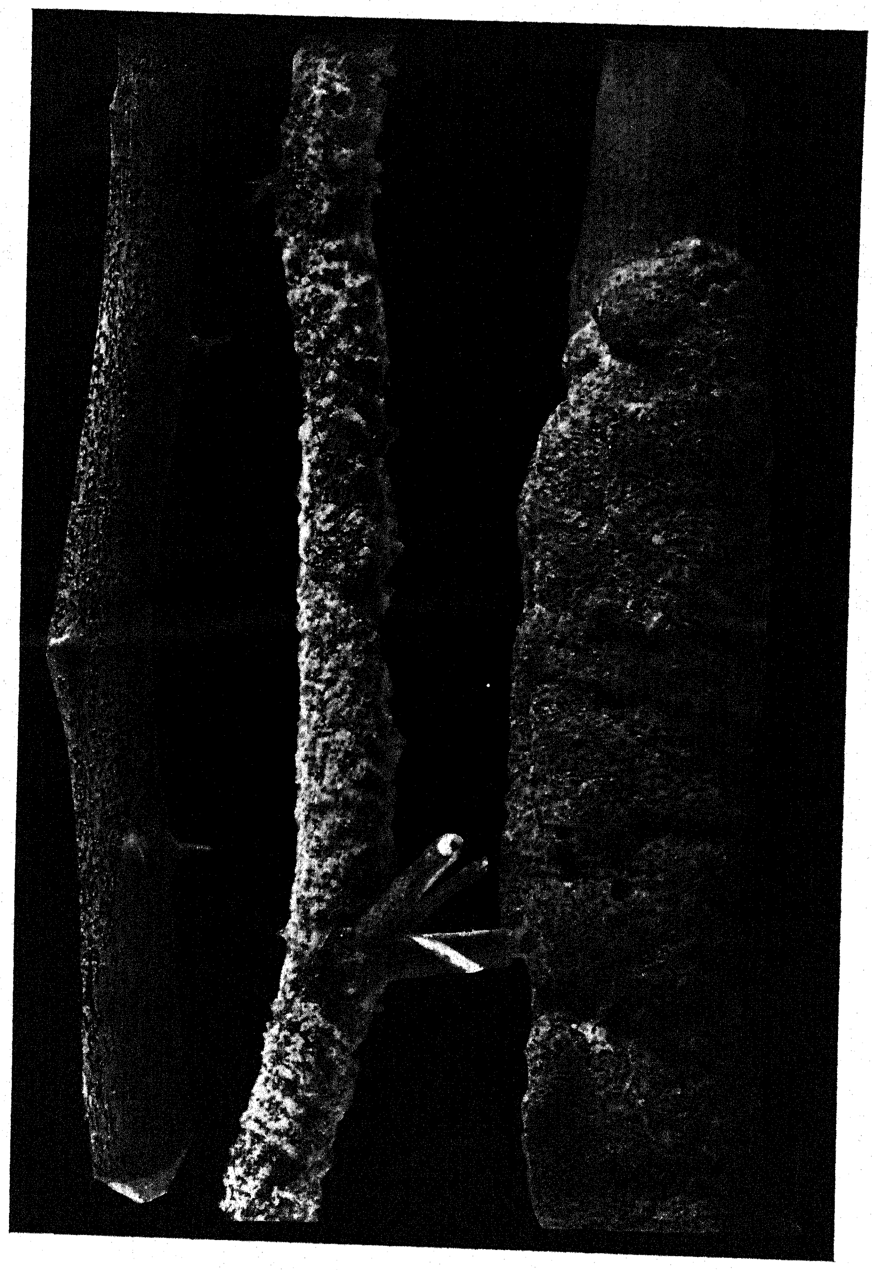
SHELLAC is the resinous covering of several species of scale insects, which live upon a variety of trees, suck out the sap and exude a covering of a resinous nature as a protection. These insects occur on a very large scale in the forests of India and are cultivated for the value of their covering. The raw material is collected from the trees and is worked up into various forms, more or less purified, in which it is exported from India. A very large amount is also used in this country, and there is a constant and increasing demand for this product.

Shellac is recognised as one of the most valuable of forest products while its value as an agricultural product is very largely neglected. It is this aspect of lac cultivation that is discussed here, as there is a large field for extension in this product in the agricultural areas of India, on lines quite apart from those on which the forest product is developed.

Shellac is produced by scale insects of the genus *Tachardia*, of which four species are known in this country at present while there are probably more. The scientific discrimination of these species has never been done nor is it for our immediate purpose necessary but the fact must not be lost sight of; it is of the greatest practical importance, since the species have differing foodplants and seasons, and in commencing cultivation one must know the season of the species one is dealing with as well as its alternative foodplants. Unfortunately not much is known of this aspect of the subject and those who have written about lac in the

PLATE XXV.



A. J. I.

LAC ON BER.

On the left a twig, showing the young settled down shortly after inoculation. In the middle, half-grown healthy lac showing the characteristic white fluffy appearance.

On the right, mature lac from which the young have emerged. In the middle, is a single hole from which has emerged the moth of a caterpillar that feeds on lac. (All natural size.)

past have almost wholly ignored the fact, to the confusion of the subject and the failure of experimental trials.

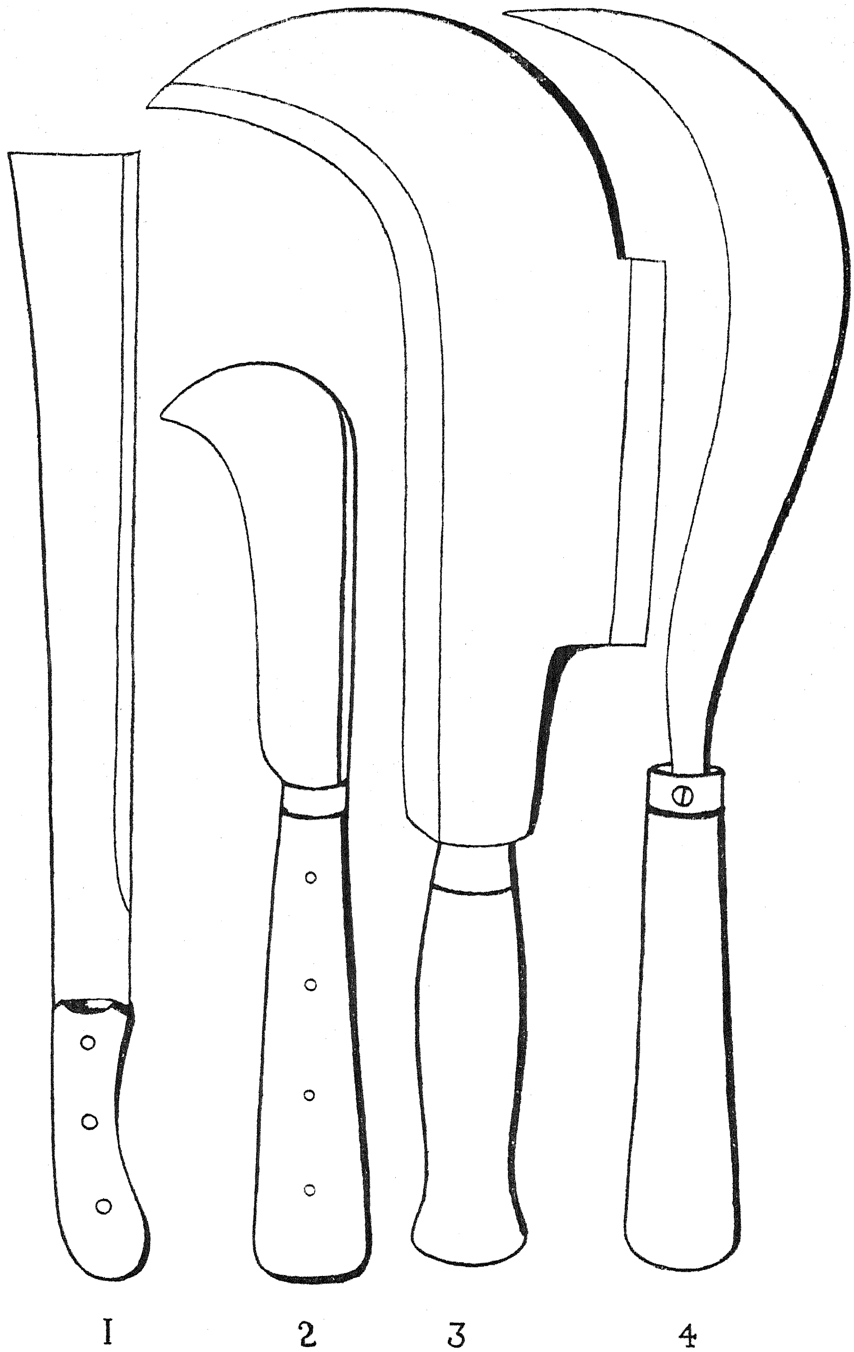
Ber Lac.—We will consider here first the lac, which is cultivated on the ber or wild plum tree (*Zizyphus jujuba*). Like other lacs, it has two broods in the year ; in Behar, the eggs hatch in June, the young insects grow until October, when they are full-grown and lay eggs ; these eggs hatch and the insects grow until the following May. There is thus an emergence of young insects in June and in October, varying in date from season to season but always about then. In commencing cultivation one must have trees ready pruned, or in such a state as to take the insects, by June or October and one must have arranged for a supply of brood-lac at that date. The seed is then " inoculated " or put on the trees, and by end of September, or middle of June, the young insects produced by that brood emerge and are put on to other trees which must be ready for them. The trees on which this first crop were grown will then be ready for a fresh inoculation by the following June or October, when the eggs of the second brood hatch out. Thus each tree bears one crop a year and rests between, some trees bearing lac from June to October and then resting for the cold weather, the others bearing the crop from October to June and resting during the rains. During the resting period, new shoots grow out and are ready for the next inoculation. In order to prepare the tree for the first inoculation, it must be pruned long enough beforehand to have grown stout new shoots by the time the brood-lac will be ready. In starting cultivation then, one prunes as many trees as one will have brood-lac for, say six months beforehand ; when the lac insects are hatching out, one puts the branches on to these trees and " inoculates " ; at the same time one prunes more trees to be ready for the next inoculation. After that no more pruning is required, except when putting lac on to trees for the first time, as the mere cutting off of the lac-bearing shoots when the crop is ripe, is a sufficient pruning and provided every tree bears a crop once a year, the mere reaping of the crop is the natural pruning. In Behar, the sequence would be : December 1909 :—Prune trees

and arrange for seed-lac. June 1910 :—Put lac on the pruned trees (*i.e.*, inoculate) and prune more trees. October 1910 :— Use the lac from the first trees for the second lot. Prune more trees if required for the next inoculation. May 1911 :—Put lac from the second lot of trees back to the first and on to any new trees.

The sequence will be the same for every kind of lac and tree, depending on the season at which that lac matures and can be inoculated, where inoculation is done in this manner on the shoots.

For successfully working lac, one must be familiar with the more important points of the life history of the insect. These are illustrated on Plate XXIV, and can be readily observed on the tree. When one obtains seed, one gets a branch encrusted with lac, this being the united covering of a large number of full-grown females. These are full of eggs, inside the resin, and these eggs hatch to little insects, which emerge from the cells and crawl about on the branch. When this branch is fastened to another, the young insects crawl up the latter and fasten themselves down. Plate XXV illustrates the young insects, fastened down in abundance on the twig. The young active insect is shown in Plate XXIV. It is very small, reddish in colour, with three pairs of legs and a pair of feelers ; it walks actively till it finds a suitable spot where it inserts its beak into the tissues so as to get food and then settles down. At the first moult it becomes legless and scale-like, a fixed insect as shown in Plate XXIV. From this time, if a female, it never moves. If a male, the perfect insect (after some weeks or months) comes out and mates with the immobile females. So that, some time after inoculation, the males will be seen walking about on the branch. The males are winged or wingless, and are small reddish insects as shown on Plate XXIV. For ber-lac, they emerge in August from the June inoculation, in January-February from the October inoculation. The appearance of these male insects must not be confused with the emergence of the young insects. The males mate and die ; the females then grow rapidly and secrete shellac until their coverings unite into the fully developed lac incrustation.

PLATE XXVI.



VARIOUS FORMS OF PRUNING KNIFE.

1. A good pattern, a heavy straight blade for pruning.
2. A tea-pruning knife for trimming cut-ends.
3. A bill-hook for very heavy work on big trees.
4. The ordinary Indian pattern made in the bazaars at a cost of eight annas.

Each insect has white filaments projecting through the shellac covering, and these give the incrustation a white appearance denoting health. These filaments keep open a way for the excrement and for the admission of air. The female is now encased in shellac, and her body becomes full of eggs. These she lays in the cell and gradually recedes before the eggs, her body shrinking as the eggs are laid till she dies having laid her eggs. This occurs in June or late September for ber-lac and the eggs then hatch.

The above is an outline of the life of every lac insect and the important point is to know the emergence of the males as well as the emergence of the young. Plate XXV shows well the appearance of half-grown lac with its fluffy white covering and this is a sign of health and vigour. The insects drop their liquid excretion, which, drying on the leaf of the plant, provides a medium for the growth of sooty mould, thus making the leaves black ; this is immaterial and is not a sign of disease.

The lac insect requires to be placed upon parts of the plant which have a soft rind and will yield abundant juice ; the best position is on newly-grown shoots which are not too small and, in actual practice, inoculation should be done on robust new shoots and in such a way that the lac insect does not cover the shoot too far up towards the tip ; when the stick of lac is put on the branch, the young swarm off it and walk on to the new branch ; they settle down at once, in groups on the shaded side of the twig away from the sun, and the first emerged settle down nearest the point to which the stick is fastened, the later ones moving further and further up the shoot ; when the shoot is covered for a sufficient distance the stick of seed is removed to a fresh place so as to avoid over-inoculating a shoot.

Inoculation is done by tying the sticks of ripe lac on to the branches of the prepared tree, either across two shoots or along a single shoot, this depending upon the size of the shoots and of the mother lac. If the stick of mother lac is big enough to inoculate two shoots, one ties it with its ends resting against two shoots, both of which will be inoculated.

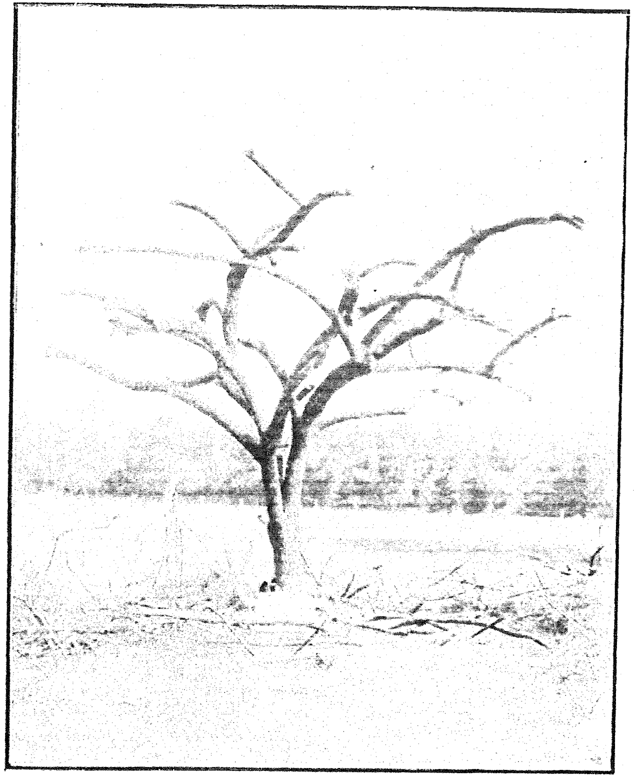
Experience is needed to know the time when the lac is ready to emerge and to be put on to the new shoots. The appearance of the first young ones is a guide; if experience has shown the actual dates in previous seasons, it is better to cut the lac beforehand, say a week before the time of emergence but only experience can decide this for each locality. One must then at once cut all the lac, cut the branches into lengths of eight to ten inches, rejecting those parts not covered with lac and either apply them at once to the new shoots or stack them carefully on two parallel bamboos with the ends of the sticks free till there are numbers of young insects on the ends of each stick; the sticks are then used for inoculation. After a week or so, the sticks are removed and brought in for scraping. The lac is scraped off the stick and well washed; in washing, the lac dye is removed and used as dye or as manure; the washed lac (seed-lac) is put up after drying and sold.

If all the lac is not being used for inoculation, that not required for inoculation is cut before the emergence of the young and is at once scraped and washed or is stacked to allow of the emergence of the young. Better lac is got and a larger quantity and this work should all be finished before the inoculation is to be done.

As stated above, there are two crops on ber, one obtained in May (Baisakhi) and the other in October (Kartiki). The former is the best, partly because it has longer to mature, but also because it is much less attacked by enemies. If a cultivator has 25 trees, he should inoculate only five in May for the Kartiki crop, to provide seed for the other twenty for the Baisakhi crop, and always only so many trees should be inoculated for the Kartiki crop as are necessary to provide seed. If one is increasing one's stock and all the seed-lac required is not available, one inoculates as many trees as possible each time.

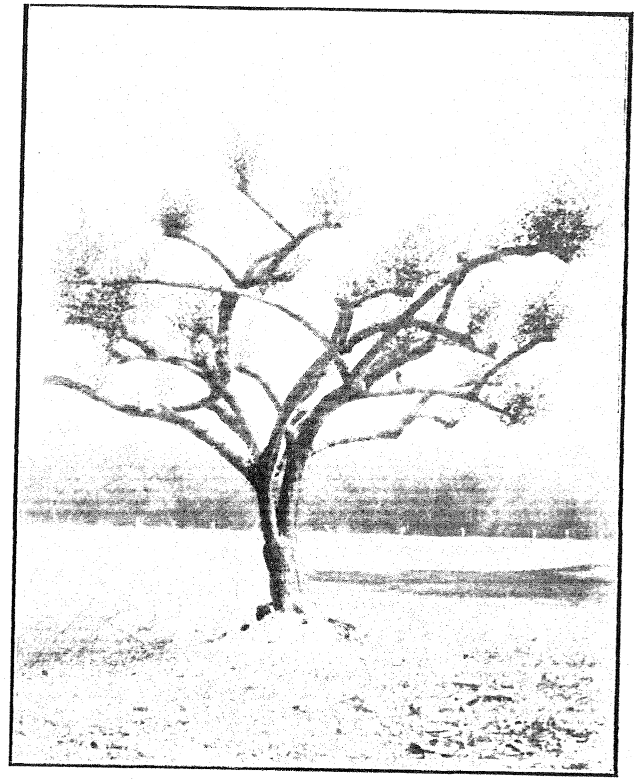
Pruning.—Photographs are reproduced here showing a pruned tree; this tree was a very vigorous tree and the pruning was very severe. Old trees will not bear so drastic a pruning but the system is the same; one cuts every branch back to stimulate a bushy growth of strong shoots. One should do this

PLATE XXVII.



A. J. I.

TREE VERY SEVERELY PRUNED; 3RD DECEMBER 1907.



THE TREE ON 3RD MARCH 1908.

in January for the June inoculation. For pruning one requires simply a heavy knife; we illustrate some patterns of which the long straight one (No. 1) is the best. Pruning must be done with straight clean cuts, leaving no jagged ends in which water can lodge to cause decay. The proper pruning is a very essential thing if the vigour of the tree is to be preserved and it is a wise precaution to tar the cut ends. After the first heavy pruning only the light pruning done in removing lac bearing shoots is required.

Cost and Yield.—We cannot estimate the actual cost of commencing cultivation because the initial cost of seed-lac varies very much, as does the cost of labour. At Pusa, we commenced by buying twenty-five bundles of seed-lac for Rs. 25; we inoculated 118 trees, mostly small ones, and the work of pruning and inoculating cost Rs. 12-7-6. In the following October we inoculated 150 trees, of which fifty were large and fifty medium in size; in June we inoculated 353 trees and a quarter of an acre of arhar (*Cajanus indicus*) at a total cost to date of Rs. 72; against this is to be put the sale of lac scraped after inoculation, amounting to Rs. 55. After this the profit and loss account is useless as a large part of the lac is distributed over scattered factories in Behar from which returns are not available. The approximate yield from this area has been ten maunds, selling now at Rs. 200 and giving a profit of Rs. 185 on the total crop plus over a thousand trees inoculated and a quarter of an acre of *arhar*.

The following is a very reasonable estimate of the expenses, etc., for a cultivator owning twenty-five trees, allowing lac to be selling at Rs. 20 per maund, the present approximate price, the lowest for eight years :—

FIRST YEAR.

	Rs.	A.	P.
Pruning twenty trees, one coolie, three days, at 0-2-6 per day ...	0	7	6
Seed-lac, 25 bundles at 4 as. each	6	4	0
Inoculating trees	0	15	0
Scraping lac	0	10	0
Knife	1	0	0
Total ...	8	4	6

SECOND YEAR.

	Rs.	A.	P.
Dressing the trees, one coolie, 2 days	0	5	0
Inoculating	0	10	0
Scraping lac	0	10	0
Miscellaneous	0	7	0
Total ...	2	0	0

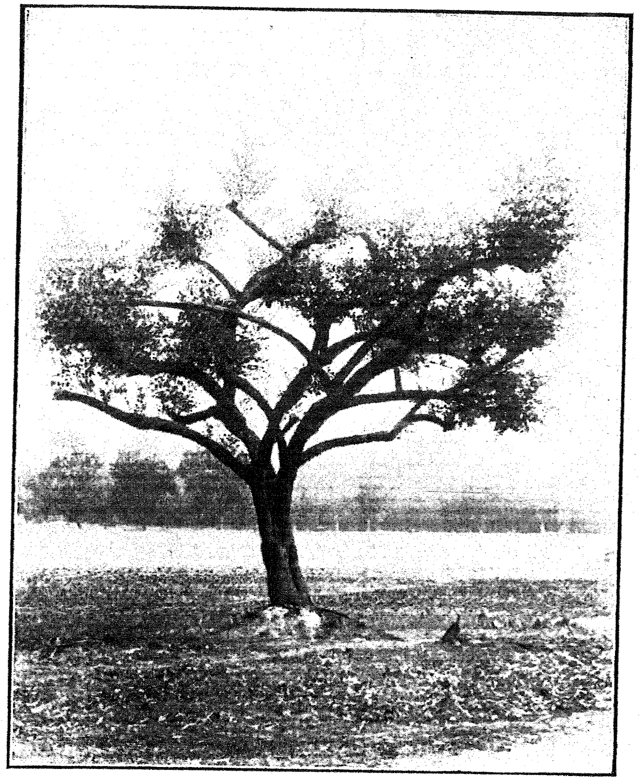
Lac obtained from seed purchased	9 seers
Lac obtained in first year	½ maund
Lac obtained in second year	½ maund
Total ...	1 m. 9 s.
At Rs. 20 per maund	Rs. 24-8-0

The net profit is Rs. 14-2-6 and his annual profit Rs. 8.

This is an extremely conservative estimate, as a yield of only two seers per tree is very small. A large tree will yield up to ten seers and more if properly inoculated, and we have based our figures on the constant use of the lac for seed; if he cuts the bulk of his lac obtained in May before the emergence of the larvæ, not using it for seed, he should get a yield per tree of Re. 1 at least. We have also included in our estimate the labour as a charge. Where the cultivator does this himself, as he should do, the actual money return is more, and practically, after buying the initial seed-lac and the knife, there are no expenses and only a few days labour twice a year.

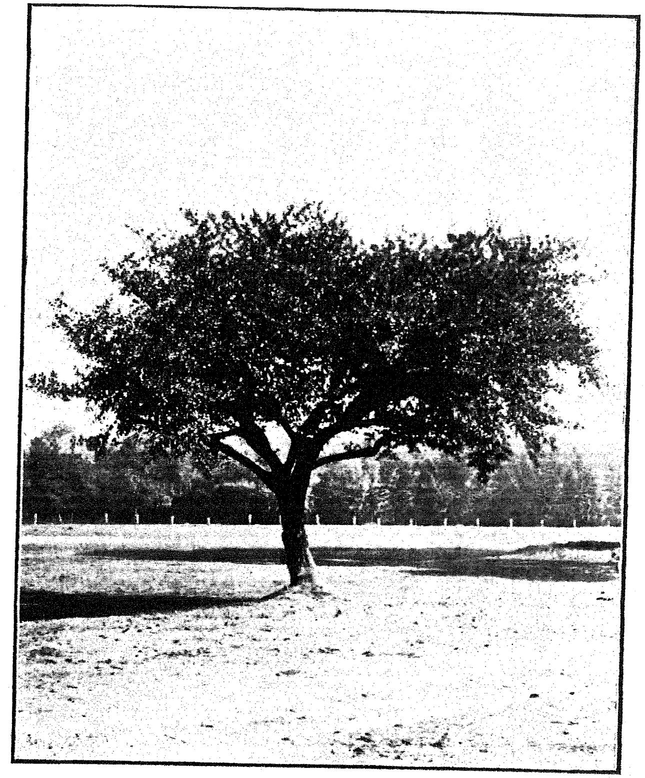
We have at present discussed only ber-lac, because it is the lac that will be of most value in the agricultural areas of India on large scale. Ber lac is second only to kusum-lac in value, as a cultivated lac; the tree grows very freely on neglected land in many parts of India; it is found wild in uncultivated land to a very large extent and covers much land that is otherwise unprofitable. In Behar land covered with ber is commencing to yield a good return without cultivation or special growth of trees, by utilising the existing trees; the trees are cleared, pruned and inoculated and where such trees occur they will yield excellent lac and are already, on some Behar factories, bringing in a return. The bulk of the lac grown at Pusa has been distributed to these

PLATE XXVIII.



A. J. I.

THE SAME TREE AS IN PLATE XXVII ON 3RD APRIL 1908.



THE TREE READY FOR A FULL INOCULATION.

factories, and has done well. Wherever ber is available, there can lac be grown, unless the climate be a very dry hot one, and it is necessary only to procure the seed-lac in the first place. In parts of Bengal, as in the Santal Pergunnahs, ber is extensively cultivated for lac, to the displacement of other crops and it is the best of the available trees for this purpose, in agricultural areas outside the hills.

Other kinds of lac.—Until a complete survey of Indian lacs is made, it is not possible to indicate the scientific name of the various lacs that occur. As a quite distinct variety is the lac found on kusum (*Schleichera trijuga*), the best lac in India. In the hill tracts of Bengal it is the best and most extensively grown lac; but the tree is of limited occurrence in agricultural areas and it is as a forest lac that it is pre-eminent. Where the tree occurs, it is above all suited to lac cultivation, and should be used. The lac matures in July and in January, its seasons being quite distinct from those of ber lac; kusum lac must be used for its inoculation.

Far more important as a lac in agricultural areas is the pipal lac, found on a variety of fig trees (*Ficus*, spp.). It is widely spread over India and is a source of the lac used in the manufacture of bracelets and lac turnery. It is not cultivated; when a tree has a crop, the crop is cut or is collected when it falls off; reproduction is in the former case effected from fragments left on at gathering, in the latter case is natural. The insect occurs in the same way as many scale insects do and, while there are two broods a year, about the same time as ber lac in Behar, a crop is usually obtained only once in two to three years, because there is no system of inoculation. Nor is such a system possible; such trees as pipal do not lend themselves to pruning and inoculation and the utmost that can be done is to spread the lac from tree to tree by ascertaining the season at which the young swarm and then tying twigs to all pipal trees not already infected In such a manner there could be a very large extension of lac production, which would be improved by some care in gathering the lac properly and in leaving on a sufficient amount to serve as seed.

Ber lac grows upon the dhak or palas tree (*Butea frondosa*) and upon arhar or tur (*Cajanus indicus*). It is cultivated upon both and both plants are a valuable source of lac. Where dhak is found, it should be used and seed can be obtained from arhar if available. Attempts are now being made to utilise the dhak trees on otherwise unprofitable lands in the United Provinces, but it is not certain that they will succeed. Arhar is used in the Central Provinces and Assam, and is being used in Behar. The difficulty lies in getting good strong plants at the right time and, if one is to inoculate in both May and October, the crop must stand for 15 to 24 months in the ground. It is thus a matter of local conditions if the plants will stand this. In Behar, the plants in February are pruned for the June inoculation or cut down for the October inoculation, but it is by no means certain as yet that even in Behar it will be profitable.

Another lac grows upon litchi (*Nephelium litchi*) and siris (*Albizzia lebbek*). It is a very good lac but is not of much importance. Litchi is of no value as a plant to grow it on, and its other foodplants are not very good.

A very important plant is the babul (*Acacia arabica*), which in Sind bears lac which is of great value. There could be a very large extension of lac cultivation on this plant which grows freely in very wide areas in India. On this tree especially there could be a very large production of lac on canal banks, on wastelands and wherever this tree occurs. Its potentialities as a lac producer equal that of ber and there is immense scope for rendering profitable lands that are now of little value except as a source of firewood and grazing for goats. Babul lac is apparently a distinct species and to start the cultivation one must obtain the mother-lac from babul. It is obtainable in Sind, Rajputana and the drier parts of North India (? also in the Eastern Ghauts), and is not known to occur elsewhere.

The Extension of Lac as an Agricultural Product.—The object of this article is to point out the possibilities of lac as an adjunct to the cultivation of crops and we may briefly indicate the steps to be taken in any locality to introduce lac and

PLATE XXIX.

A. J. I.

SCRAPING STICK-LAC.

commence cultivation. There are at present three methods of obtaining lac.—

(1). It is collected from certain trees which bear natural lac whenever the tree has a crop, a little being left on to serve as seed.

(2). It is systematically inoculated and collected from trees once a year, the trees being worked on the system described above for ber.

(3). It is cultivated on annual plants which bear only one crop and are then taken off. Arhar or tur is the most important example.

Where lac is found on pipal, banyan, siris, etc., it can be increased by spreading it to all the trees of that kind, by inoculating the trees, without previous pruning, from lac-bearing trees of the same kind. There is a very large field for extension of lac in this way and the only necessary thing is to ascertain for each locality what is the proper season for the inoculation, *i.e.*, the time at which the young emerge. Furthermore, a sufficient supply of lac to serve as seed should be left on when the crop is harvested to quickly cover the tree again. Trees which yield lac in this way include pipal, banyan, gular, pakur, babul, kikar or khair, siris, asan, and others of less importance. As the trees that bear lac like this vary immensely in different parts of India, one can only suggest that in every case, where lac is found on trees not pruned, that it should be spread to all the trees of that kind if possible.

The most important cultivated lac is that grown on the system described above on kusum (*Schleichera trijuga*), dhak or palas (*Butea frondosa*), ber (*Zizyphus jujuba*), babul (*Acacia arabica*), khair or kikar (*Acacia catechu*), and other trees. The trees used must be small enough to be pruned and handled and any lac-bearing tree that will stand this treatment will be suitable to this kind of cultivation. When any of these or other lac-bearing trees occur in wastelands, on bunds, along roads, scattered in the fields, along canal banks, by rivers and in nullahs, the lac suitable to that plant should be obtained and inoculated.

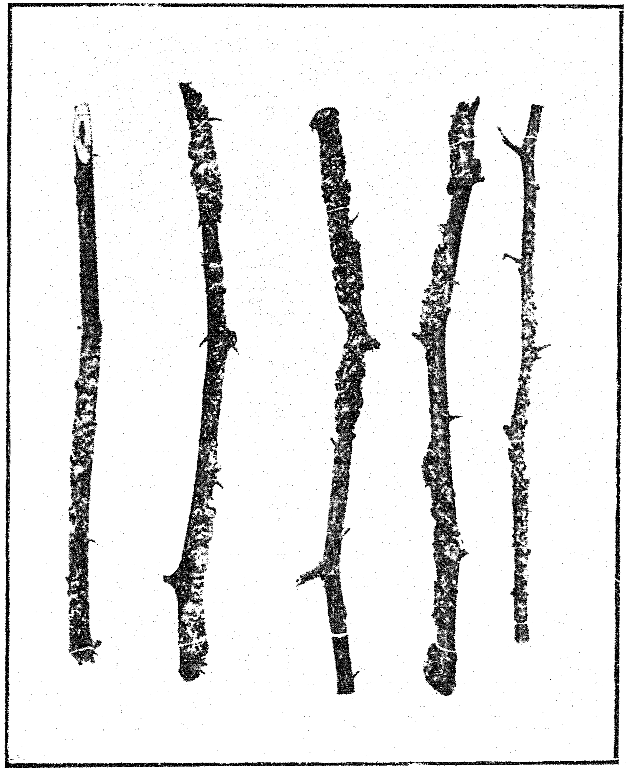
If only a few trees can be inoculated as a commencement, a start will be made. As a rule, lac will be found on enquiry to occur sporadically here and there and one has only to ascertain when the young emerge and then to utilise all the available lac for inoculation.

The field there is for extending lac cultivation in this way in India is immense and while it does not interfere with the yield of fuel from such trees or with the grazing of the land they are on, it makes an otherwise unproductive tree a source of profit, at a very small expenditure of labour twice a year. Lac cultivation on these lines was commenced in Behar in 1907. Lac is now being cultivated on otherwise unproductive trees in a number of factories and the entire outturn of seed is utilised in extending it; it is only at the beginning now and we could advantageously use a hundred times the amount of available seed. This might apply to almost any agricultural tract in India, not necessarily with ber lac but with the trees and lacs locally procurable.

In this article, we desire only to draw attention to the advantages of lac cultivation in agricultural areas and, for so diversified a country as India, one article would not suffice to indicate the detailed steps to be taken in every district. The important points are to ascertain the available trees, whether lac occurs on them locally, the nearest source of lac, the season at which the young emerge (swarm). One must then prune or, if the tree grows too big, simply inoculate. When ber, kusum or dhak occur, then there is little difficulty; equally if figs occur. Mother-lac, if cut at the right time before the first young are out, will travel for some distance. We have sent it for 24 hours by rail and the original lac from the descendants of which the present Behar lac is being obtained, came from a long distance by road and rail.

Lac of all sorts suffers from pests and enemies, and a few simple precautions may be taken. When the young insects are on the trees, ants come to them, not to feed on them but on the sweet excretion they give forth. It is said that the young

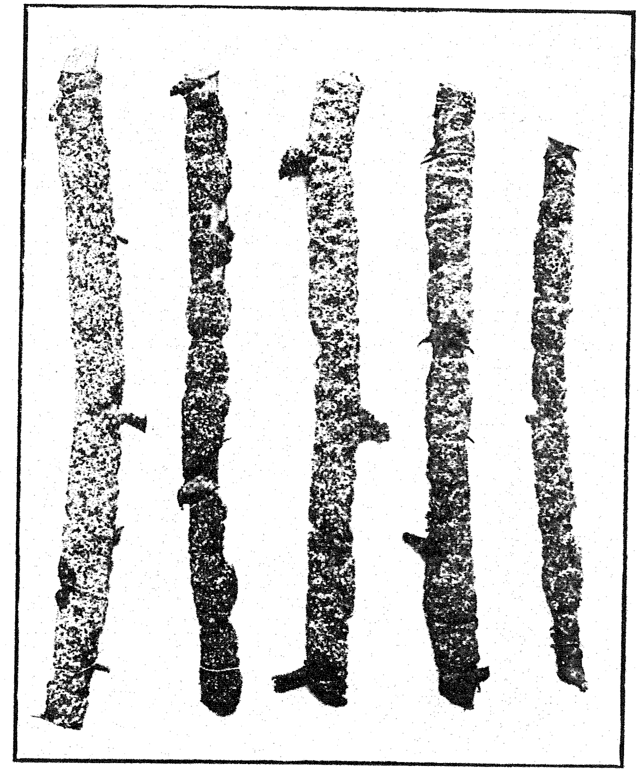
PLATE XXX.



A. J. I.

STICKS BADLY COVERED.

Fig. 1. Sticks of lac well inoculated.



STICKS WELL COVERED.

Fig. 2. Sticks of lac insufficiently inoculated.

insects suffer from these ants but it has never been proved that they do. As a rule, ants do no harm, but they may be kept off by strewing ashes round the foot of the trees or by painting a ring of tar or grease round the trunk of the tree low down. A much more serious enemy is the caterpillar which feeds in the lac incrustation. There are several species (*Eublemma* and *Hypatima*) which are found in lac on the tree and which continue to feed on the stick-lac after it is cut and brought in. There are others (*Ephestia*, etc.) which attack the dried stick-lac after it is harvested. These are worst in the May-October crop, and occur far less in the cold weather crop. For that reason with ber, the trees inoculated in May are few, since there is no practical cure. There is one important point; as soon as the lac is cut or has been used for inoculation, scrape and wash it; otherwise the caterpillars will eat and spoil it. If stick-lac must be kept, then fumigation is the only remedy. But, it is always best to sell the lac as "seed-lac", *i.e.*, lac from which the dye has been removed by washing and which is in the form of small fragments. Lac-dye is now-a-days of so small value that we do not advise its separation unless there is a special demand for it. If large quantities of lac are being handled, extract it and sell it as dye or manure. But for a small home-industry, as we advocate lac cultivation, the lac-dye may be washed out.

Lac cultivation in the way we advocate here is being carried out at Pusa now and can be seen there. Instruction in pruning, inoculation, scraping, is given twice yearly when the work is being done on the estate. Those who wish to can come and learn or can send some one to learn. For those too far off, we shall be glad to give any help or information in our power and as trained men are available in some Provinces, those desirous of assistance or information should apply to the Agricultural Department of their Province. A limited amount of assistance can be given from Pusa with trained men. At the present price, lac is a remunerative industry; the present prices are the lowest for eight years and as there is a steady demand and a limited

source of supply, the price will remain at least where it is and probably advance. There is room for a very large cultivation of lac as a valuable crop in the agricultural areas of India; both where wastelands and trees are abundant and where there is a large population on densely cultivated areas as in Behar, the estimated value of the lac annually produced is near six crores of rupees and there is room for a very large extension of cultivation before the market will be lowered by overproduction.

The cost of growing lac in this way is so small, as compared with the cost of doing it in forest lands, that even at the present low prices, it is worth while for the agriculturist to whom it is only a minor industry; if the crop fails, the total loss is a few days' labour; if the price is low, as it is now, his expenses have been so small that he can still get a profit and the cultivation can go on independently of the fluctuating markets.

THE MANAGEMENT OF EXPERIMENT STATIONS IN INDIA.

By KHAN BAHADUR MIRZA ABDUL HOSAIN,

Moulmein.

The *Agricultural Journal of India* (Vol. III, Part IV, for October 1908), contains an article on the "Management of Experiment Stations in India," by Mr. B. P. Standen, C.I.E., I.C.S., Director of Agriculture, Central Provinces; and in a footnote the Editor invites criticism on it. As a private agriculturist I wish to offer some remarks on the subject.

Mr. Standen begins by stating "that the object of an Experimental Station is not to make a profit, but to solve certain problems of sufficient importance to warrant the expenditure of public money." He then goes on to say "that the area allotted is too large (about 200 acres), and so much money is spent on good buildings and cattle that the stations do not pay. The first thing which strikes a cultivator who visits a station fitted in this way is the enormous cost of the arrangements. He at once draws the conclusion that if the crops are better than he can raise, it is due to lavish expenditure beyond his means. He sometimes doubts whether even the fine crops which he sees on the ground will pay for the expenditure which he incurs, and if he asks for information, he is told that there is a large loss on the station, and that it is not intended that it should pay. This sends him away with a very natural, though a wrong idea of the value of the work that is being done."

I consider the writer is inconsistent. If the object of an Experiment Station be what he says, then no reasonable expenditure by the Agricultural Department should be spared in

solving problems of agricultural importance to the country. The Agricultural Department in India has been established for the purpose.

Mr. Standen apparently compares the costly buildings for men, cattle, stores, machinery, implements, etc., with the buildings on ordinary cultivators' holdings. I admit that the buildings on some Government farms are much too costly, but if the work on these farms is to be carried on by men of any education (European or Native), how would it do to house such men in dirty hovels and to let them work with wretched cattle and antiquated appliances as used by native cultivators? Moreover, is it not likely that the existence of better buildings and plant on these Experimental Farms will induce the native cultivators, at least those of them who can afford to do so, to improve their farmsteads?

Mr. Standen then states that the first thing that strikes a cultivator who visits a Government Farm is its enormous cost, and the cultivator draws the conclusion that if the crops are better than his own, they are due to high expenditure which he cannot afford. He is told on enquiry that they do not pay; whereupon he goes away disappointed. I should like to ask Mr. Standen if any cultivator has attributed the excellence of his Government crops to the existence of the costly buildings there. If so, why has this error not been corrected? The native cultivator really need not ask for an opinion on this point. He has the practical knowledge to know that the crops are good not because a costly building is standing by.

Why should he be told that the crops on the station do not pay, in order to go away disappointed? He should be told that money is spent on experiments the results of which may be for his benefit in order that he may take continued interest in the work of the Station.

Further, Mr. Standen states—" It must be recognised that agriculture cannot give the same returns in India as in Europe, *because cattle are not kept for food* (the italics are mine), and the quantity of farmyard manure available must be much less

and is as a matter of fact extremely limited." I think this statement is a little exaggerated, for, I believe, farmyard manure can be made available in large quantities in almost all parts of India, if some care is taken for its storing. If in the Central Provinces farmyard manure is not available in large quantities, it is probably due to the fact that it is made into cowdung cakes and sold for fuel.

I would like to point out that every experiment should at first be on a small scale. If successful, then it should be extended on a considerable area to see if it will pay from a commercial point of view.

The statement with which Mr. Standen starts is true, namely, that the object of an Experimental Farm is not, and should not be, to make a profit. It should be to evolve methods for the improvement of Indian agriculture. Many experiments may fail and much money may thereby be wasted. This is inevitable.

In my opinion the whole question comes to this—is the agricultural condition of India perfect or not? If it is perfect, then abolish the Agricultural Department and close the Experimental Farms. If it is not perfect and if there is room for improvement in agriculture and in the material prosperity of the country, then the yearly expenditure on the Experimental Stations—provided the money is judiciously spent—need not be seriously considered. I think, it is unfortunate that Mr. Standen should have written as he has, at the present moment, when the Agricultural Department is still in its infancy and when we expect great results from its researches.

HEART DAMAGE OF BALED JUTE.*

By R. S. FINLOW, B.SC., F.C.S.,

Fibre Expert to the Government of E. B. and Assam.

THE more recent work on which the above report is based arose out of a correspondence between Messrs. Cross and Bevan and the writer of this review on the subject of the natural moisture content of jute fibre. In July 1907 an arrangement was made for collaboration in an investigation into the causes and possible methods of prevention of "Heart Damage" in jute, on account of which 3 per cent. of the total imports of jute into Dundee in 1906 was said to have been rejected.

Points dealt with in the report.

For practical purposes, the report may be divided into the following sections :—

(*a*) A technical description, with analytical figures, of the change which takes place when jute undergoes "Heart Damage."

(*b*) A description of the condition, on its arrival in London, of jute treated and baled in India by the Fibre Expert to the Government of Eastern Bengal and Assam.

(*c*) Recommendations.

Description of "Heart Damage"

Taking these sections in order, we find that "Heart Damage" † is a deterioration of jute involving a radical alteration in its properties, both physical and chemical. Physically, instead of remaining a fibre of considerable tensile strength, it becomes a spongy brittle mass, which can easily be rubbed into a fibrous powder. "Heart Damage" jute is therefore entirely useless for

Changes produced by "Heart Damage."

* Report to His Majesty's Secretary of State for India by Messrs. Cross & Bevan, on investigations of jute fibre in relation to "Heart Damage" of baled jute.

† So called because the effects of the deterioration appear first in the centre of the bale of jute.

spinning purposes. The chemical change produced is equally great, the most important characteristics being—

(1) Great diminution of cellulose content.

(2) A far larger proportion of the weight of the fibre becomes soluble in water or in simple chemical reagents.

(3) Diminution of the yield of furfurol in the distillate obtained on boiling the fibre with Hydrochloric Acid.

These changes, which may be taken as typical, to some extent, of organic decay, are summarized in the following table :—

	(a) Normal fibre.	(b) Damaged fibre of same bale.
Moisture	10·7	9·8%
Ash	1·2	1·3%
Constituents soluble in water	1·1	11·5%
Soluble on boiling with 1% caustic soda for 5 minutes	11·0	23·3%
Ditto ditto for 60 minutes	14·0	58·3%
Furfurol (total)	7·8	5·8%
Phloroglucol absorption	4·2	8·0%
Chlorination reaction	8·9	10·2%
Cellulose after dissolving the chlorinated derivative	75·0	62·6%

Diminution of cellulose.

A heart damaged sample of jute examined by the writer showed an even lower figure for cellulose than that quoted above, and the proportion of soluble constituents was also correspondingly higher. The cellulose content of a fibre is probably the most important criterion of its durability and the great diminution of so important a constituent shows the deep-seated nature of the deterioration.

Increased proportion of soluble constituents.

The increased proportion of soluble constituents is only to be expected; but it is worthy of notice that nearly one half of the soluble matter consisted of, or was easily resolved into, sugar-like bodies, a fact which indicates hydrolytic distintegration of the cellulose constituents.

Diminished furfurol yield.

The conclusion to be drawn from the diminution of furfurol is not quite certain; but it is possibly a sign of deoxidation, which would be an indication of anærobic fermentation.

The microscopic aspect of the change indicates that it is similar to that produced by strong hydrolysing acids, *i.e.*, the fibre bundles are attacked integrally rather than resolved into their constituent ultimate fibres. The disintegration was not produced by moulds, because in no case was it found that the mycelia of the mould growths present had penetrated the fibre bundles.

Microscopic effect produced.

One of the conditions necessary for the development of "Heart Damage" is moisture. When the investigation was first taken up, it was thought that "Heart Damage" could be produced with less water than now appears to be the case. Consequently in the baling experiments dealt with in the report the amount of water added was only sufficient to bring the total water-content up to rather less than thirty per cent. The experiments were devised to obtain the following results:—

Conditions necessary for the production of "Heart Damage."

Baling experiments.

(1) To produce "Heart Damage."

(2) To see if the presence of easily fermentable matter such as sugar would tend to hasten the deterioration.

Objects of baling experiments.

(3) To see whether "Heart Damage" could be prevented by addition of a small quantity of an antiseptic to the fibre.

On being opened in London, about three months after making up, none of the six bales showed any obvious sign of deterioration and the contents were sold in London as high class fibre. Thus, none of the objects aimed at in the experiments were obtained, because, having failed to induce "Heart Damage," the effect of antiseptics in inhibiting its progress could not be gauged.

Result of baling experiments.

Samples from each of the bales were incubated aerobically for forty days at 35°C.; but, as was to be expected, no results were obtained, beyond strengthening the probability that "Heart Damage" takes place under conditions which are not aerobic. The baling experiments are regarded as tentatively justifying the following conclusions.

Conclusions from results of baling experiments.

(1) That the presence, in clean baled jute, of nearly 30 per cent. of water does not cause any evident damage even after many weeks.

(2) Even the presence of easily fermentable matter together with this amount of water is not necessarily harmful.

(3) Mould and aerobic bacterial growth may develop on the fibre without causing deep-seated changes therein.

(4) Formaldehyde appears to have a more powerful preservative effect on jute than corrosive sublimate, both substances being used in solutions of the usual strength.

Attention is called to the fact that the phenomenon of "Heart Damage," resulting, as it appears to do, in the production of nutrient matter available for living organisms, though undesirable in the case of jute, might become a most desirable process, under control, for the utilization of lignified waste or by-products such as sawdust, etc.

Recommendations.

In recommending the continuance of the investigation, Messrs. Cross and Bevan advise that a series of experiments be carried out on a practical and commercial scale, comprising the addition of 7 to 14 lbs. of formalin per ton of baled jute. This advice is based on two assumptions :—

(*a*) That the cause of "Heart Damage" in jute is biological and that it can therefore be prevented by treatment of the jute with an antiseptic before baling.

(*b*) On the fact that a sample from one of the formalin treated bales sent to London showed an apparently greater resistance to alkaline hydrolysis than the contents of other bales.

Such experiments must be premature until the cause of "Heart Damage" has been elucidated. However probable it may be, it has, as yet, by no means been proved that the deterioration is due to bacterial agency. Moreover, it is not yet certain that the deterioration, when it takes place in baled jute, is not avoidable even without treatment with antiseptics. The second reason advanced for the proposed experiments is based on evidence which requires considerable confirmation before it could

justify the expenditure contemplated by Messrs. Cross and Bevan. It will, however, be quite easy to test the effect of formalin on jute in the laboratory.

Proposed organization in England for the investigation of "Heart Damage."

In a later communication than the report before us, Messrs. Cross and Bevan also propose an elaborate scheme which would undoubtedly prove very expensive, for the investigation in England of "Heart Damage." In view of the fact of the existence of the Indian Agricultural Department which is now fully equipped to undertake the Scientific side of such an investigation as the one in question, an organization in England to investigate "Heart Damage" seems superfluous; it should be remembered, too, that the raw material is available in India in any quantity and at cost price, also that it can be produced under conditions which can be varied at will. There is moreover in India, as in England, a large commercial community, which is willing to assist, as far as possible, in the solution of problems affecting its interest.

Ability of the Indian Agricultural Department to undertake such investigation.

Results already obtained in India.

It may be said in this connection that typical heart damaged jute has already been produced at Pusa under fairly well defined laboratory conditions, and that some further progress has been made towards the elucidation of the causes of the deterioration.

The first part of Messrs. Cross and Bevan's report constitutes a valuable scientific essay on the general characteristics of "Heart Damage" in jute; but the recommendations at the end would appear to be somewhat premature until the causes of the deterioration have been carefully worked out in the laboratory.

RICE CULTIVATION IN LOW-LYING LAND IN BURMA.

By KHAN BAHADUR MIRZA ABDUL HOSAIN,

Moulmein.

THERE are extensive tracts of low land in Lower Burma which are lying waste owing to their being inundated during the latter portion of the rainy season, in August and September. In some places the water rises four or five feet high. When the water subsides, sowing or transplanting cannot be done as the rains cease in the beginning of October; nor are these tracts fit for cold weather cultivation because such crops do not get the few necessary showers.

It appeared to me that the method of cultivation in vogue amongst the Burmans was faulty, and that by altering the method, it might be possible to combat the floods successfully.

The method practised by the Burmese in this district is to begin ploughing after the rains have well set in and the land becomes soft. Sowing or transplanting is done generally in July. In August—the month of the floods—the paddy plants are only about two feet high, and when submerged for a few days, they perish.

It occurred to me that if the ploughing could be done in the dry weather, and the sowing before or immediately after the setting in of the rains, at least two months would be gained, and the plants might be tall enough in August to resist or survive the floods. But two difficulties were suggested against this change. First, that land could not be ploughed, and, secondly, if the sowing were early, the crops would mature correspondingly earlier, *i.e.*, before the rainy season was over and that, therefore,

reaping and threshing would be practically impossible while the rainy season continued.

It became also clear to me that the country ploughs could not plough dry land, but it might be possible to overcome this difficulty by other appliances or improved ploughs; besides, if the plants got into ear correspondingly earlier, the continuance of the rains would retard their maturity and thus make the grain fuller and richer.

I accordingly decided to make an experiment. I imported a few English ploughs from Messrs. Ransomes, Sims and Jefferies, of Ipswich, and began ploughing in January. For the first three or four days it was uphill work, and my men regarded the use of the ploughs as hopeless. After some perseverance the men learnt to handle them. These ploughs did good work when yoked each to two buffaloes. My men have since discarded country ploughs in favour of Ransomes' English ploughs both for dry and wet weather ploughing. The kinds marked E. C. and S. R. A. W. in Ransomes' catalogue are most in favour, though we use some of the smaller kinds for lighter work.

Having finished ploughing, I began sowing. For broadcasting the Burman soaks the seed two or three days to sprout. The practice, though all right when water is standing in the fields, appeared to me to be open to two objections. In the first place, if by the time the seed has sprouted there should be a break in the rains, the sprouted seed cannot be held back, and if broadcasted, would be liable to perish. In the second place, the sprouted seed is liable to be injured by handling. I therefore decided to try new methods—new at least to this district. The first was to broadcast dry seed on dry land and then to give the land light ploughing to cover up the seeds.

The second was to raise the seedlings by irrigation before the rains commenced, and to transplant them immediately after the rains set in. Both these methods succeeded exceedingly well. By the month of August when water rose to five feet in the land the paddy plants were six feet high, and so were not submerged and survived the floods. Furthermore, the plants

were reaped when ripe about the same time as the later sowing on other fields.

The kinds that grew best were *Yehini* and *Shangley.* The qualities of both were as superior as those grown on ordinary paddy lands. These experiments have been under successful trial for three years.

It has thus been demonstrated that on low-lying lands, where floods do not permit of good paddy being grown according to the ordinary methods, it can be grown successfully if cultivated earlier than usual.

Besides there was an advantage in ploughing land during the dry season. A plot of land which in previous years when ploughed during the rains produced poor crops and was looked upon as poor land.

This area yielded excellent crops when ploughed in the dry weather. This proved the advantages of dry weather ploughing and exposing ploughed land to the sun.

This method of dry weather ploughing is being adopted by some of my neighbours who now see that under certain circumstances, a departure from old methods is conducive to improved cultivation.

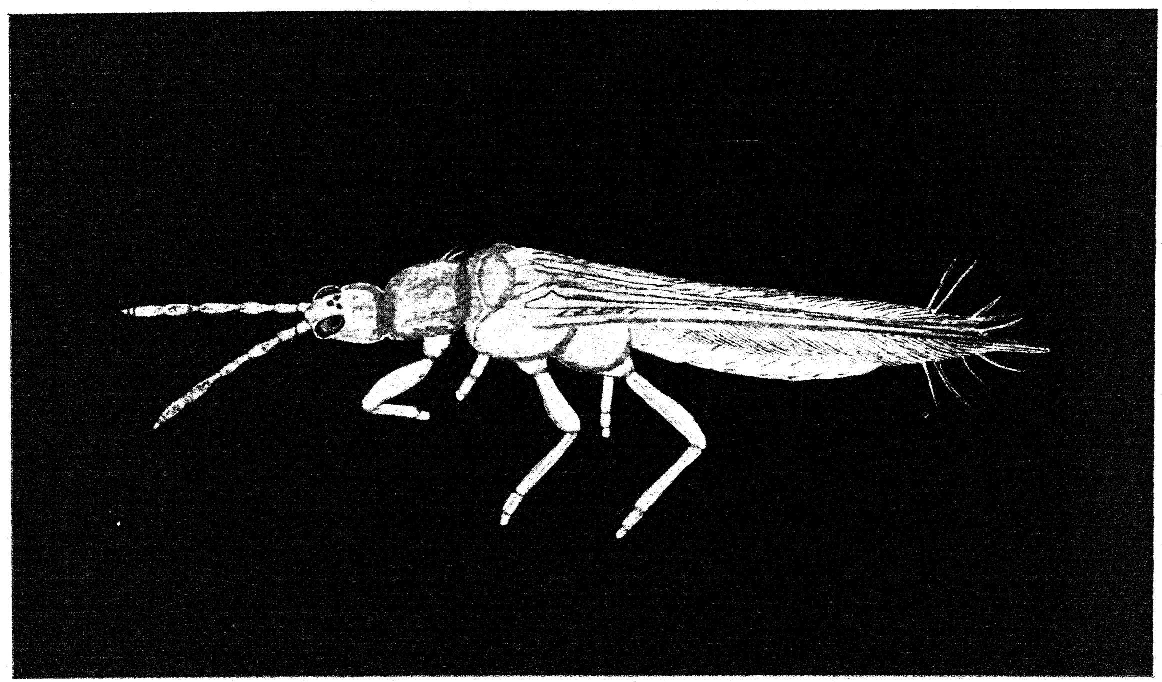
For low-lying lands there is, of course, the water-resisting paddy known by the Burmese names of Todaungbo or Yemanaing which for the last two years has been making headway in this district; but the grain does not find favour with the millers.

NOTES.

Thrips in Tea.—Thrips is a small insect which is found upon tea bushes and is associated with a diminished yield of leaf, due to the shoots not growing. The full grown insect is about 1/15th of an inch long, the colour brown or black, the body slender, with two pairs of narrow wings fringed with long hair. It is found on the shoots, upon the upper surface of the young leaves or buds, frequently in the opening leaf while it is still curled. It runs actively about and may be easily seen if the shoots are examined. The young are like the full-grown insect, except that they are wingless, of a yellow or red colour and more fragile. They are found with the adults in or on the shoots; the quite young ones are almost white, very small and delicate, found on the very young leaves or in the curled leaf. They hatch from eggs laid in the soft tissues of the leaf or shoot. There is one kind of Thrips abundant on tea and others found more rarely; the damage is practically all done by two species. The most important points are that the young are like the adult (*i.e.*, there is no grub or caterpillar stage) and that the living insects are found on the shoots throughout their active life. (Plate XXXI.)

Thrips injure the shoots by scraping at the leaf, destroying the epidermis and projecting veins, weakening the leaf and interfering with its nutrition. The leaf becomes brittle, loses its fresh green colour, and the whole shoot ceases to grow. The leaf and shoot do not normally die, but simply become unhealthy and remain stunted. The damage done by Thrips is totally distinct from that done by such insects as Green-fly or Aphis, which bury their beaks in the tissues, cause only a small puncture and suck out the juice from inside. Thrips cannot do that, but rasp

PLATE XXXI.



A. J. I.

THRIPS IN TEA. × 40.

the leaf, destroying the surface tissues. Thrips also feed on pollen and they live normally in flowers. It is said that tea made from thrippy leaf is devoid of flavour; that opinion is not endorsed by all planters, and the experience at Phoobsering is that there is no loss of flavour, but a very heavy loss in weight of leaf plucked.

It is impossible now to account for the increase and abundance of Thrips on tea in the Darjeeling District. It has probably been on tea since tea was first planted. It is also likely that the damage it has caused has frequently been confused with that caused by Green-fly or other pests. It is extremely likely that past dry seasons have caused it to increase either directly by being favourable to it or indirectly by producing abundant blossom. I believe it is accurate to say that in dry weather the Thrips flourishes, that normally during the rains it is more or less inactive, and that its most active season is when there is fine dry weather and perhaps plenty of blossom. Normally in wet weather the Thrips is very much hampered by the wet leaf, the finer leaves often holding drops of water, and it is far less active in cloudy cool weather than under bright sunshine. Equally it is less abundant and destructive under shade. When we consider that the insect spends its life on the small leaves, we can believe that the constant wetting of these leaves checks the activities of the insect, and that it thrives in dry weather. Whatever may have caused it to increase, it has been abundant and has caused damage There is the greatest diversity of opinion among planters as to when it was first noticed, but there is a general agreement among those who answered my circular that the loss is about a half to one maund of tea per acre on the affected blocks. Most planters report damage during 1908, and principally at high elevations; the China *jat* and poor *jats* of hybrid are attacked far more than good *jats*.

Treatment.—No special precautionary measures are possible against Thrips, except such commonsense ones as depend upon keeping up the vigour of the plant; it is not associated with any other plant, wild or otherwise, which can be destroyed;

mechanical methods of catching it on a large scale do not seem feasible; it must be destroyed upon the shoot, and this can be done only by means of insecticides applied to the bushes; dry insecticides, such as sulphur, are of no avail, as none is known that will destroy the insect; and the only possible method of destroying it is to spray it with a liquid contact poison. From the replies received it is evident that no treatment has been tried on a large scale, though on some gardens experiments have been made.

During the course of experiments at Phoobsering, various contact poisons were tried; such insecticides as soap, oil-emulsions and rosin solutions are all effective at the proper strength, and the problem is simply to find the one which at the necessary strength is the cheapest. Crude oil-emulsion, soap, and rosin compound were all tested carefully, and for each one separately the equivalent strength required was ascertained by spraying bushes with weak and gradually stronger solutions, collecting after each spraying a number of leaves with Thrips on and watching these till the Thrips either died or recovered; if the Thrips recovered, the solution was made stronger till the effective strength was found. On working out the cost of these various solutions, it was found that rosin compound was the cheapest. The relative cost of crude oil-emulsion, soap and rosin compound at equivalent strengths is Rs. 5, Rs. 4, Rs. 2-8 respectively, the first alone requiring no fuel for heating. Rosin compound has also the advantage of being an insecticide that "wets" extremely well, that dries rapidly, forming a varnish of rosin over the bud or leaf, and that penetrates extremely well into a curled-up leaf. That rosin compound is effective has been ascertained in several ways; observation of Thrips on sprayed bushes shows that, if wetted, they do not recover on being dried or if not dried; with weak strengths of these insecticides the Thrips may be wetted but recover on drying; observation and counting of Thrips on the bushes show that with ordinary spraying a very high percentage of the Thrips actually on the bushes are wetted; it would be impossible to spray every one simply

because with ordinary work it is impossible to be sure that every shoot is sprayed; (it has also been found that actually almost every sprayed Thrips is washed off the bush; this must be remembered as after spraying one finds very few dead Thrips on the bushes though many have been killed, and total number is very much reduced). Lastly, the improved appearance of the sprayed bushes, as compared with unsprayed bushes, is very marked; we have sprayed blocks of tea, leaving neighbouring blocks unspread, and the improvement in the appearance of these blocks, after a week or fortnight, has been extremely marked. It must be remembered that not only does the wash kill the insect, but by varnishing the leaf it prevents the insects feeding till the rosin flakes or washes off. In this way the best treatment for Thrips has been extremely carefully worked out at Phoobsering, and I believe that the most practical method of checking Thrips is to spray with rosin compound; no other remedy equally practicable or cheap has been found, and this appears to be the best and simplest treatment. I rely almost entirely on the appearance of sprayed bushes, as compared with unsprayed ones, in concluding that this method really does lessen the number of Thrips; we know that Thrips, sprayed with this insecticide, is killed; but it is not possible in practice to actually estimate the number killed per bush, the percentage killed or the real direct effect, chiefly because of the very small size and the activity of the insect.

Cost of the Treatment.—Rosin compound is prepared in this way: a gallon of water is warmed and a pound of soda dissolved in it; it is then boiled and two pounds of powdered rosin added; boiling is continued, while cold water is added slowly till the whole amounts to four gallons; during this boiling the liquid from being thick and soapy, becomes a clear brown, thin and not soapy; it is then ready and taken off the fire. This mixture (stock solution) is then diluted with water for spraying at the rate of 7 pints to $3\frac{1}{2}$ gallons, *i.e.*, 7 pints are put into a four gallon tin or spraying machine, and the tin filled up with water to almost the top. I tried using it at 4, 5 and 6 pints t

the machine full of water; at 6 pints it kills Thrips; at 5 and 4, it kills only some; I believe 7 to be a strength at which all Thrips will, with absolute certainty, be killed if wetted.

Spraying is done with ordinary Knapsack Spraying Machines, the spray being directed to the *tips of the shoots* so as to reach the Thrips there. Success Knapsack sprayers made by the Deming Co. with their Bordeaux nozzles have been used and are recommended, but any machine giving a fine enough spray may be used.

The amount of wash used per acre varies up to 130 gallons for well-grown bushes; we filled the machine 36 times, *i.e.*, 36 times 7 pints of stock solution were used, or 31½ gallons. Four gallons of stock solution contain 2lbs. of rosin and 1lb. of soda, so that 32 gallons require 16lbs. of rosin and 8lbs. of soda. The amount used per acre is thus 16lbs. of rosin and 8lbs. of soda on the average; soda costs Rs. 7 per cwt. or 1 anna per lb. Rosin not more than double that; the total cost per acre for materials is then Rs. 2 for rosin, and annas 8 for soda, total Rs. 2-8. If mono-hydrated soda is used, costing Rs. 7 per cwt., 11 oz. should be used, reducing the cost of soda to about 5½ annas; with labour the average cost comes to about Rs. 3 per acre for each spraying.

In actual working we found that, having two men to each machine carrying and spraying alternately, an acre could be done daily. Experienced men will do more, and it is not always necessary to have two men to each machine, since one man can do the whole thing; it is better as the work on sloping blocks is tiring and by changing each time the machine is filled, the men work more rapidly, there are also required men or boys to bring water, etc. We have found that two men with one machine do one acre daily, each two machines requiring one man to bring water (the latter varying, of course, with the place). Ten machines with 25 men can ordinarily do 60 acres per week, the amount varying with the distance from which water must be brought, the size of the bushes and the efficiency of the arrangement. We have actually found this figure easily worked up to in practice.

One item also must be added, and that is, labour and fuel for boiling the stock solution ; for each acre, 32 gallons must be boiled. Initial requirements for 60 acres per week will be :—

Ten machines at Rs. 50. Five barrels or other vessels to hold stock solution and water. Four 5-gallon drums or other vessels to boil up to 20 gallons of stock solution at one time. (If available, a large vessel holding 20 or more gallons at a time would be best.)

The spraying is done by marking out the block and working along the lines from one side, each machine having four or eight lines marked for it ; the men do two lines of bushes at a time and walk up one row, down the next row but one, so returning each time to the side having done four rows ; they then take the next unoccupied four rows, and the whole number of machines gradually work down the block, the barrel in which water is collected and the stock solution moving along from time to time so as to be close at hand.

The spraying machine recommended, which I believe to be the best, is a Knapsack one, *i.e.*, one carried on the shoulders, with a small force pump worked by a lever over the shoulder, a reservoir holding four gallons, a $\frac{3}{8}$th inch rubber tube 5 feet long and a brass spray nozzle adjustable to give a fine spray or to close. There are no rubber parts to get out of order except the tube, which is easily renewable, but which ordinarily lasts for several years ; the only part eequiring adjustment is the packing at the top of the cylinder which is easily got at and repacked. If too much pressure is got up, *e.g.*, by the man pumping when the nozzle is closed, the rubber tube may be blown off the pump, but it is easily put back. After spraying is finished, if the pumps are not to be used for some time, they must be washed out with clean water pumped through the machine, or the rosin dries and fixes the position. These pumps are equal to any other kind available, and there is a stock now available in India. The pumps last for years, the rubber tubing alone being perishable. They cost from Rs. 40 to Rs. 50, depending on the reservoir being galvanized or copper.

The rosin used is ordinary fir-tree rosin, obtainable in India at prices varying from Rs. 6 to Rs. 10 per maund. Our rosin cost Rs. 12-9-0 per cwt. landed in Darjeeling and mono-hydrated soda Rs. 9-13-0 per cwt. The soda used is ordinary crystal soda (washing soda); if it is wet or impure, more than a pound must be used, or the stock solution will not boil clear, and this can only be found by adding a little more if the stock solution after being boiled and gradually brought up to four gallons will not come clear. If mono-hydrated soda is used, then a less quantity is required as it contains a greater proportion of soda, and we have found 11 oz. to two pounds of rosin enough. The soda need not be pounded as it dissolves readily, but the rosin should be in particles not larger than coarse sand. The mixture is not poisonous, and if properly made, the stock solution will keep indefinitely. It cannot be bought ready made except at an extravagant price. In filling the machine, 7 pints of stock solution are poured in, always through the strainer, and the machine is then filled up with water; the stock solution must be put in first so as to get well mixed.

There are small points regarding machines, method of work, etc., which are best learnt by seeing the work actually in progress. The nozzles require adjusting at first to a fixed point, so as to give the right spray, as the men do not at first understand them. If an automatic nozzle is required, then the Vermoral should be ordered. I believe that this method is thoroughly efficacious, that it can be carried out with very little difficulty on any tea estate, and that if done thoroughly, Thrips can be thoroughly checked; with one spraying the Thrips will be so reduced that it will not be destructive for that season; with two at an interval of a week to a fortnight, almost every Thrips will be killed; absolute extermination is impossible.

Thrips spread slowly and does not fly long distances; infection from neighbouring unsprayed blocks will, I believe, occur slowly, and it seems certain that it will be profitable even only to spray the worst blocks; it will be more profitable to spray large blocks throughout, and the effect will be more lasting.

The best time to spray is at the commencement of a flush before the new leaves are too large, but the spraying can be done at any time when the weather is not actually wet. It is useless doing it in wet weather, but so long as it is not actually raining, and there is time for the liquid to dry, say two hours, then spraying will be effective. I am not able to say at what time of the year spraying is best done; we have done all our spraying in April-May and September-October. If a block of tea is thrippy, spray at the first opportunity. Later on when we have had more experience, we can decide, if there is one season better than another, and whether it will pay to spray the whole garden; for the present I would advise spraying first the worst pieces and seeing that the results justify.

Mr. Irwin has suggested that the treatment must be varied according to the condition of the bushes. The new growth made from pruned tea in the first season is of so much importance that it will pay to spray such tea twice to ensure a complete eradication of thrips and to secure a thoroughly good growth during the first year. With unpruned tea, the damage done by Thrips is temporary and not permanent, and a single spraying, done whenever required, will probably be sufficient. We are working on these lines, spraying the pruned tea twice, so as to make perfectly certain of a good growth throughout the season.

It is probably best to spray pruned tea as early as possible, at the beginning of the first flush if Thrips is active with a second spraying between the two first flushes or doing both sprayings after the first flush. It may be dangerous to do the first spraying too soon as the thrips must be active on the young shoots if the spraying is to be effective. As far as possible all spraying is probably best done in the interval between the first two flushes when the labour is available and there is usually a spell of fine weather. From the 7th May to the 15th June seems to be the time at which the work can be done in the Darjeeling district; this applies particularly to pruned tea, but it will be better to spray unpruned tea also at this time if it is thrippy and if it can be done.

Sprayed leaf has been plucked and manufactured within one week after spraying, and the flavour has not been altered. It is apparently perfectly safe to spray up to within one week of plucking with no effect on flavour, and it is probable that the safe period is less than one week. Either there is nothing in the rosin-soda compound that effects flavour, or it is washed or flaked off within a few days, or else it is all removed from the leaf during manufacture.—(H. M. LEFROY.)

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CULTIVATION OF BROACH COTTON AT DHARWAR.—The climatic and rain conditions being favourable, Broach cotton is grown very successfully for the last two or three years round Dharwar. Broach cotton is sown two months earlier than the Kumpta variety as its period of growth is two months longer. Thus both ripen at the same time in March and April.

Broach cotton is sown before the *Aridra* rains cease, about the 10th July, to avoid damage by ante-monsoon rains. In sowing, the seed should be prepared like that of the Kumpta variety by applying mud and rubbing the same to allow the seed to pass freely through the tubes. An acre requires about 7 to 8lbs. of seed. The seed should be sown in rows of 2 feet apart.

The crop requires land which has been well manured and cultivated. Weeding, interculturing and other cultivating operations for this crop are like those of Kumpta variety.

The plants when six inches high should be thinned to 1 foot apart in the rows. In thinning, weak plants should be removed. When 1 foot or more high, the plants should be nipped off ½ inch from the top.

One *Kurgi* (4 acres) yields on an average seed cotton of about 96 maunds. Last year on the Dharwar Government Farm one naga (48 mds.) seed cotton yielded about 16½ to 17 mds. of lint.

To get the highest percentage of lint, Government have obtained from Navsari 25,000lbs. of pure Broach cotton seed, and arrangements have been made at the Government seed depôt at Dharwar to sell the seed to the cultivators at 32 lbs. per rupee.

Last year, to enable the cultivators to obtain fair prices for their cotton, Government opened a central market where all cotton grown near Dharwar was collected and sold by auction. Merchants from Bombay, Ahmedabad, Dharwar, Hubli and Gadag attended the auction sale. The price was Rs. 156 per naga (48 mds.), while Kumpta variety was sold at Rs. 115 per naga (48 mds.).

The last sale of Broach cotton took place at Dharwar on 25th April last. The Agricultural Department offered prizes to cultivators who grew the best crops of Broach cotton, and thereby excited keen emulation. The actual quantity of kapas, collected at the sale, was 336 nagas of 1,344lbs. Buyers from Bombay turned up in force and the bidding was lively. This year the Agricultural Department classified all cotton according to its ginning percentage. The price realised for each class was, on the whole, in proportion to the ginning percentage. The class ginning from 30 per cent. to 31 per cent. fetched Rs. 150 per naga, and the highest class ginning above 35 per cent. was sold for Rs. 176 per naga. The lowest class which was probably a mixture of Kumpta and Broach and was ginning below 30 per cent. fetched Rs. 135 per naga. Out of the total quantity of 336 nagas, less than 17 nagas sold below Rs. 150. The average price for Kumpta cotton was Rs. 116 per naga at Hubli on the day of sale. The auction was witnessed by over 200 cultivators who had this year grown Broach cotton.—(EDITOR.)

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NON-NITRIFYING SOILS.—It is generally taken for granted that all fertile soils have the power to convert organic and ammoniacal nitrogen into nitrate nitrogen, *i.e.*, to nitrify. Recent work at the North Carolina Experiment Station appears to prove otherwise. (See Note by F. L. Stevens and W. A. Withers in *Science*, dated March 26, 1909.)

Out of 62 samples of local soils only 29% nitrified, while 71% failed to do so under laboratory conditions.

The soil tests were made by adding nitrogenous material, organic or ammoniacal to the live soil, or by sterilizing the soil,

adding the nitrogen, then inoculating with a suspension of the soil to be tested. The soils reported as giving a negative result did not yield enough nitrate to respond to the very delicate diphenylamine test. A large proportion of those that showed nitrification had only a very minute quantity of nitrate.

Rich soils from other districts were found to give positive results. It must, therefore, be recognized as a bacteriological possibility that soils may be devoid of nitrifying power. When we consider our existing beliefs about soil fertility, it is difficult to gauge the significance of the above observations.—(W. ROBERTS.)

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PEAT.—Last year Mr. T. N. Sivanantham Pillay, Ootacamund, sent to the Inspector-General of Agriculture for analysis two samples of peat and peat moss from a big area of peat bog in his estate. These samples were analysed at Pusa. The chemical analysis of each is as follows :—

	Peat.	Peat moss.
Moisture	10·69	10·39
Organic matter	70·10	59·68
Soluble mineral matter	6·72	9·35
Sand	12·49	20·58
	100·00	100·00
Nitrogen	1·57	1·34
Phosphoric acid	18	·21
Lime	·15	trace.
Magnesia	·13	·20
Potash	·16	1·76

Dr. Leather reports that the amount of potash in the peat moss is high and that the amount of nitrogen is about usual in each sample.

As peat is usually very inert when used as a manure, Dr. Leather tested the manurial value of these samples as follows. They were mixed with damp earth in order to ascertain the rate of formation of nitrates. A comparison was made between the peat and peat moss and unmanured soil and with soil mixed : (*a*) with castor cake ; (*b*) with farmyard manure ; and (*c*) with leaf mould.

The soils were maintained with 15% moisture for 57 days and then analysed. The results were as follows :—

			Parts nitric nitrogen per million of soil.
1.	Soil only	50lbs. of nitrogen per acre.	23
2.	Castor cake		31
3.	Leaf mould		23
4.	Farm manure		35
5.	Peat		14
6.	Peat moss		31
7.	Castor cake	250lbs. of nitrogen per acre.	84
8.	Farm manure		21
9.	Peat		29
10.	Peat moss		31

The analyses do not show very definite results regarding the availability of the nitrogen in the manures used.

During the coming monsoon a pot-culture test will be made at Pusa to test the value of the peats in comparison with other manures.

In no country is peat or peat moss used to any extent as manure. Peat is, however, used largely as an extremely useful litter in horse stables, cattle byres and poultry houses. This litter is much more absorptive than ordinary litter and, therefore, keeps the stables, byres and poultry houses in good sanitary condition. The resulting manure is generally considered excellent for ordinary farm crops and in horticulture.

For easy and cheap transport the peat and peat moss should in air-dry condition be baled like hay. The binding material used in England is generally thin flexible wire with thin strips of wood on two opposite sides of each bale to prevent the wire cutting into the peat.

Peat or peat moss will in India probably be found useful as a packing material in transporting by road or rail the more delicate fruits, such as peaches, mangoes, grapes, etc. Such fruits can only be transported to considerable distances or stored for some time, if very carefully packed.

Peat in the form of a powder is now used in England as a packing material for apples and other fruits that have to

be kept for months. The packed fruit is stored in ventilated boxes.

The usefulness of peat for this purpose is being tested at Pusa. The peat bog from which the samples of peat and peat moss were obtained can supply a very large output annually.

Peat is known to exist in India not only in the Nilgiris, but also in Assam in very large quantity.

The approximate cost of baled dried peat free on rail should be as follows from Ootacamund :—

PEAT MOSS IN WAGON LOADS.

			Per cwt.
1.	Peat moss (pressed and baled)	...	Rs. 1 8 0
	Peat (do. do).	...	„ 0 12 0

FOR LESS QUANTITIES.

2.	Peat moss (pressed and baled)	...	Rs. 2 0 0
	Peat (do. do.)	...	„ 1 0 0

(EDITOR.)

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SPINELESS CACTUS.—Some of the Spineless *Opuntias* are grown in India as garden curiosities.

"The Genus *Opuntia* belongs to the American Continent and the West Indies. A considerable number of species, however, have now become naturalised in many other parts of the world."

"The fruits of *Opuntia*, or at least some of them, are edible, and to some palates they are very agreeable. Sir J. Hooker compares them to pumpkins."

O. Ficus indica is a native of Central America whence it gradually spread all over the world. It is cultivated for its fruits, which are sometimes used as dessert fruits.

The fruits of *O. brasiliensis*, *O. decumana* and *O. rafinesquii* (which is spineless) are also good to eat.

The fruits of the common prickly pear, *O. dillenii* and *O. nigricans*, are eaten by poor people in India.

Experiments in various Provinces have proved that in famine years cattle can be kept alive on prickly pear, helped by a small ration of hay or other ordinary cattle food.

In Australia, California and other parts of the world, experiments are being made to demonstrate the use, as cattle food, of all Opuntias in general, and of the spineless varieties in particular.

"Experiments conducted in California have shown that by selection and crowning of cactus plants, it is possible to produce a spineless variety valuable as a pasture plant."

Burbank's Spineless Opuntia may prove useful at least as cattle food, in a mixture, if not singly, and may be given a trial in some suitable parts of India.—(S. V. SHEVDE.)

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CULTIVATION OF TREE COTTONS.—Tree cotton is a perennial variety which may occupy the ground for some years.

The method of cultivation should, therefore, approximate more closely to that of fruit orchards than to that of ordinary field crops.

The seedlings should, therefore, be grown from seed sown in threes or fours in well-prepared soil in centres 6 feet more or less apart, or on a well-prepared nursery on a well-drained site. The seed should be sown in this nursery in March at distances of 3 inches, and the plants should be watered. In June-July (beginning of the monsoon) strong young plants will be ready to transplant into their permanent homes. They should be planted out at distances of from $5' \times 5'$ to $7' \times 7'$ apart according to variety in holes dug to a depth of about $1\frac{1}{2}$ to 2 feet. Care must be taken not to injure the tap-root of the plants in moving them from the nursery. An alternative method which is not costly and which avoids risks in transplanting, is to sow the seed in baskets made of bamboo about 8″ high and 4″ broad, placed close together with the spaces between the baskets filled up with earth. The whole space thus occupied can be watered either by hand or by flow irrigation. The seedlings should be sheltered from hot winds.

When the time for planting has arrived, each seedling can easily be removed from the basket without disturbing the roots to any extent, and to less extent than if grown in earthen pots. Well-rotted cowdung manure should be freely mixed with the soil of the hole in which each plant is permanently planted. The usual showers in India throughout July, August and September should give the plants a good start. An alternative system for trial would be to sow the seed in baskets or in nursery in July and plant out in September.

In land which is liable to be flooded during heavy rains, it is recommended that the seedlings should be planted out on small raised hillocks or on ridges.

This very general advice about tree cotton cultivation is given with diffidence because, except under very favourable conditions, the cultivation of tree cottons on demonstration areas has not been successful in India.

The plantations usually, even in return for expensive cultivation, only give a very small outturn during the first two years, and a very uncertain crop afterwards. It is possible to grow profitably a catch crop (by preference a leguminous crop) between the rows in the first season.

It is advisable that twelve months after sowing, and just before the rains, the trees should be cut down to the lower branches, and pruning should be done each year just before the beginning of the monsoon, so that new branches will bear in the following cold weather. This pruning will check the trees from bearing all the year round, which is an inconvenience, as during the rainy season the cotton bolls are damaged, and besides, the trees should have an annual rest.

After the trees have become established, they require only occasional manuring if the soil is fertile, but the plantations must be kept free of grass weeds and undergrowth.

One chief care is to fight insect pests, to which tree cotton is very susceptible. The pests, when once established, are difficult to get rid of because the trees are perennial.—(EDITOR.)

Government Agricultural Stations.—Mr. D. Clouston, M.A., B.Sc., Deputy Director of Agriculture, Central Provinces, in a recent pamphlet, has offered suggestions for the guidance of the managers of Government Agricultural Stations.

The following are his salient points, with a few additions thereon.

On each agricultural station there should be a definite programme of work, the success of which will greatly depend upon an even and otherwise suitable area being selected for each series of experiments.

In making an experiment, its object should be clearly held in view, and the results should only be considered successful when they yield a definite result either positive or negative. It may take years to come to a conclusion.

When a definite result is obtained, the next step is to determine how far it is due to one factor.

The manager of each agricultural station should see that the programme of experiments is carried out with such scientific exactness as will produce reliable results.

The area intended for experimental plots should be carefully standardized by growing an exhaustive Kharif crop suitable to the soil and climate of the locality. If this trial or trials show an uneven area, it should be discarded altogether. In coming to a decision, eye-inspection by an experienced agriculturist during the growing season is probably quite as important as actual weighments at harvest time. Crop pests (particularly white ants) and climatic conditions which are not constant may unequally affect different parts of a selected area. This often happens in India after experiments have been actually started, however carefully the experimental area may have been selected.

Areas which are usually water-logged should not be selected for experiment, but if water-logging only occurs in excessively wet years, the area may possibly be suitable if provided with surface drainage.

The soil of experimental plots should never be levelled down, as such artificial work tends to expose the unweathered subsoil in

parts and bury the weathered surface soil in others. Such treatment excepting in rice beds is fatal to scientific work.

It is desirable, if not necessary, that all the plots of a series the products of which are comparable in a single year, should at intervals of a few years be sown with one kind of crop throughout and thus re-tested for evenness. Moreover, it is important to keep the whole area of the experiment under a rotation (if the issues do not demand different treatment) and in a condition fairly similar to the lands of ryots to which the results of the experiment are likely to be applicable in a practical way.

The size of plots may vary with the nature of the experiment and the kind of crop, but should not usually be less than one-tenth of an acre or more than a quarter acre. For final comparison of outturn of crops before recommending them to ryots, the plots should be at least one acre each.

There should be an equal number of rows in each comparative plot of a particular variety of crop, and very careful regard should be given to the spacing of plants, so that in each plot of a particular variety of crop there should be an equal number of plants. This can easily be arranged in crops like cotton or Jowari. In the case of crops like wheat, gram or linseed, equal distribution of seed should be insisted on, as the exact spacing of plants is not possible.

Vacancies due to defective sowing, germination, or other causes, should be filled in by dibbling or transplanting as soon as they are observed.

In many cases for experimental work the best method of sowing is to dibble in the seed by hand at regular intervals.

Manures should never be placed in heaps on experimental plots, for when rain falls, much of the soluble plant food in such heaps will be very locally distributed or washed into the subsoil, or at least partially lost.

Highly soluble manures should be very equally distributed. Such work requires the very closest supervision of a well-trained native assistant.

The cultural treatment of each plot of an experimental series should be identical as regards preparatory tillage, seed rate, interculture, dates of operations, etc., excepting when variation in any particular is purposely intended.

Usually it will be found convenient to have a non-experimental border round each plot growing the same crop. In harvesting the crop on the actual experimental area, the farm manager can easily exclude that on the non-experimental borders by stretching a line round the edge of the plot and harvesting the non-experimental borders first.

All experimental work not of a purely mechanical nature should be done by, or under the close supervision of, a thoroughly trained Indian assistant.

Seed selection should be similarly done.

Our probationers should be thoroughly taught in such work, and also to demonstrate agricultural methods, machines and implements and be encouraged to improve such by invention.

The manager of a farm or Demonstration area should take special trouble to get cultivators interested in his practical work to visit his place as often as possible, and should be prepared to describe clearly all experiments in progress and demonstrate the advantages of such implements and machines as he can recommend for practical use. He should also explain that his work is intended to improve agricultural practice in India and increase the profits of agriculture by applying science to practice.

The farm manager should be in complete touch with District Agricultural Associations in order that the work on Government Experimental Farms and on Demonstration areas may be brought as fully as possible to the notice of at least advanced cultivators.—(EDITOR.)

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MARSHALL'S 30 H.-P. OIL TRACTOR.—This Oil Tractor is manufactured by Messrs. Marshall, Sons & Co., Ltd., of Gainsborough, England, with the object of supplying a cheap mechanical power for agricultural purposes, which may possibly be useful in India.

The Tractor is fitted with a two-cylinder engine and has three speeds, 2, 4, and 6 miles per hour. The engine can be run on Petrol, Kerosine, Benzine, Gasoline, etc. With tanks filled with kerosine it can be run for ten hours continuously.

The engine is fitted with wide travelling wheels to travel over sandy ground. In working order it weighs approximately $4\frac{1}{2}$ tons and carries 25 gallons of fuel and 75 gallons of water; it is fitted with a water-cooler and a patent pump for circulating water through the cylinder jacket. (Plate XXXII.)

The engine can be used for ploughing, harrowing, cultivating, sowing, reaping and hauling; it can also be used for driving any fixed machinery such as threshing and winnowing machines, corn and cake grinding mills, chaff-cutters, etc., without any addition or alteration. This engine drives 3′ 6″ full size Marshall's Threshing Machine fitted with Chaff fan, Bhoosa rollers and Bhoosa shifters continuously for five hours with a consumption of $1\frac{1}{2}$ gallons of kerosine per hour. One man is required to operate it.

Experiments in India show that it can plough $1\frac{1}{2}$ acres of land that has been previously broken, per hour, with a consumption of less than 2 gallons of "Chester Brand" kerosine oil, and uncultivated land at the rate of one acre per hour with the same consumption of oil.

The cost is Rs. 8,000. The Deputy Director of Agriculture, Bengal, saw the machine at work at Semapore and reported thus:—

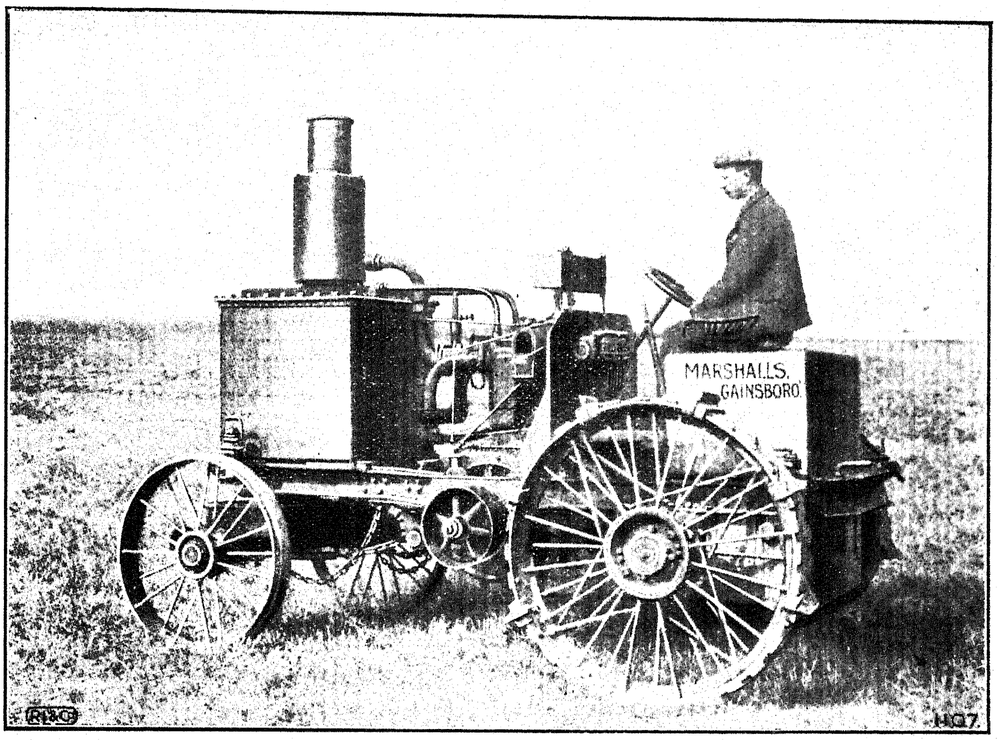
"We were only able to test the ploughing, as there was nothing to thresh and no pumps or ordinary machinery to be worked. Soil tested by ploughing was sandy loam. Two four-furrow ploughs were attached to the back of the Tractor and 8 furrows 6″ deep and $9\frac{1}{2}$″ wide were ploughed at one and the same time.

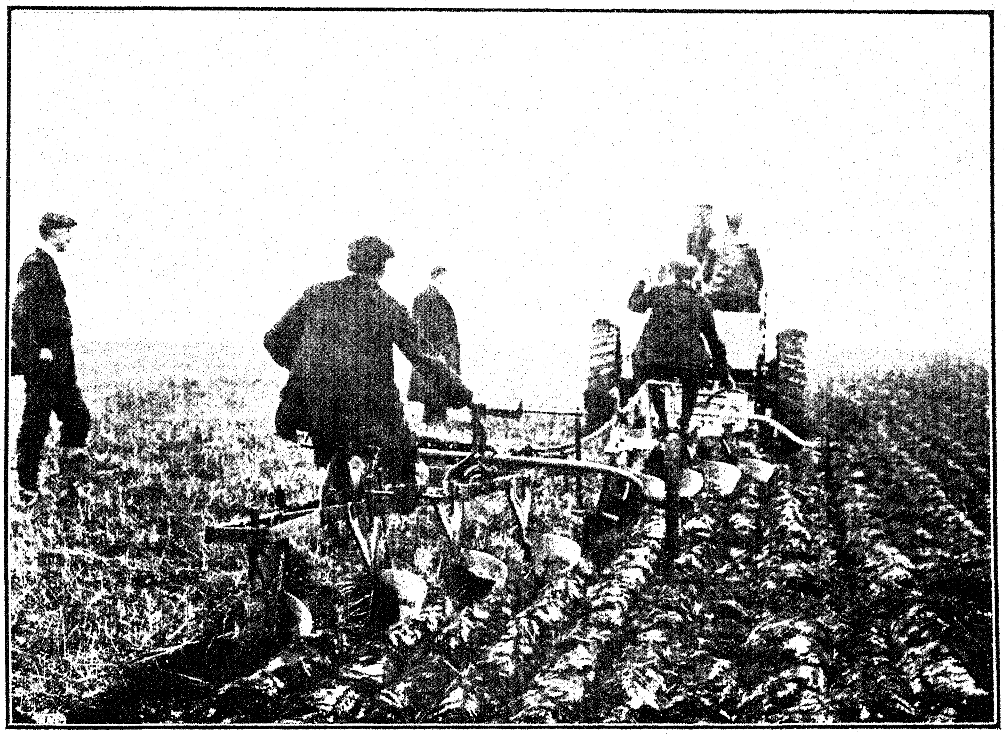
"Ploughs :—Cockshutt's (Canada) Four Furrow: Plough cost Rs. 300.

Work done—

9 Acres in 7 hours.

PLATE XXXII.





A. J. I.

MARSHALL'S 30 H.P. OIL TRACTOR.

Oil used—

15 gals. Chester Oil.
½ gal. Petrol.
½ gal. Lubricating Oil.

Quality of work done: Excellent.

Fuel:—Cost of working per acre—

	Rs.	A.
Kerosine	8	7
Petrol	0	10
Lubricating Oil	1	12
	10	13 ÷ 9 = Re. 1-3.

Cost of fuel per acre = Re. 1-3. 13 acres can be ploughed per day of 10 hours.

Cost of working per day—

	Rs.	A.	
1 Mistri at Rs. 60 per month =	2	0	per day.
2 Coolies „ 10 „	0	12	„
	2	12	per day.
Cost of fuel per day (13 acr.)	15	8	
	18	4	per day.

Cost of working by bullocks—

1 Man and pair of bullocks = ½ acre per day.

1 Man	at As. 6
1 Pair of bullocks ...	„ 6
	12 per day.

To plough 13 acres per day would require 26 ploughs—
26 × 12 = 312, *i.e.*, Cost per day = Rs. 19-8.

Capital Outlay—

	Rs.
Oil Tractor and ploughs	9,000
Bullocks and ploughs	3,000

"Accordingly, without considering initial outlay, where ploughmen can be got at 4 annas and less per day, it is cheaper per unit to plough by means of bullocks.

"The Oil Tractor will not suit small holdings or paddy cultivation, but where large holdings of high land cultivation are concerned and where labour is scarce and dear, the Oil Tractor is an economical motive power for ploughing.

"There is no doubt about the utility of this Oil Tractor. In addition to ploughing, threshing, pumping, sugar-cane crushing and carting, etc., can be done, but in Bengal unless the holding is compact and 200 to 300 acres in extent, high land cultivation is concerned, and ordinary labour costs Re. 1 per head per day, it will be found there is no advantage in changing the ordinary system of cultivation now in vogue in the Province."—(EDITOR.)

REVIEWS.

FIRST REPORT OF THE COMMITTEE OF CONTROL OF THE SOUTH AFRICAN CENTRAL LOCUST BUREAU, PRETORIA, 1907.

IN this report an account is given of the formation of a Central Bureau of the South African Colonies to co-operate against the attacks of locusts in the several colonies, and of its working. Locusts commit extensive damage to crops throughout South Africa, and in Natal particularly measures were adopted against them with success; the value of these measures was largely discounted by the arrival from neighbouring colonies of swarms of flying locusts which replaced those already destroyed and the Government of Natal moved the other colonies to co-operate in the destruction of locusts. This co-operation depends for success upon some efficacious remedy of which one has been introduced in Natal for some years and the action now taken is largely the result of the work of the late Mr. C. B. Simpson, Government Entomologist, Transvaal. The actual formation of the Bureau dates from 1906, a Conference being assembled by the High Commissioner to discuss the project. The Committee of Control of the Bureau consists of one representative, an Entomologist or Locust Officer, from the Cape of Good Hope, Natal, Transvaal, Orange River Colony, Southern Rhodesia, Basutoland, and the Bechuanaland Protectorate. The Governments of German South West Africa and of Portuguese East Africa have since become associated with the Bureau and contribute towards its maintenance.

The Bureau is located in Pretoria and its funds, borne by all the colonies, are administered by the Director of Agriculture of the Transvaal. In each colony, information regarding the

occurrence and location of locusts swarms is collected and sent to the Bureau, usually by special post cards. The Bureau tabulates these and circulates the information. The Bureau also advocated legislation to compel measures being taken against locusts and makes recommendations to the various Governments. The Committee of Control prepare an annual report, of which this is the first. They have a Secretary entirely for their work, who tabulates the reports and distributes Monthly Maps showing where locusts are. When necessary, telegraphic information is also sent.

The first meeting of the Bureau was held in 1907, and it was associated with a meeting of ministerial representatives from the various Governments to consider and lay down a definite policy regarding locust destruction. At this Conference, the action taken in the past was fully discussed and the conference adopted certain resolutions ; they emphasised the importance of destroying locusts in the hopper stage ; they pointed out that the expenditure incurred was very small in comparison with the value of the crops saved ; they endorsed the value of one remedy, using the sweetened solution of arsenite of soda as a poison for the destruction of young locusts.

These recommendations represent the combined experience of many years of the men engaged in locust destruction in South Africa and they are unanimous in adopting a single method of treatment. The remedial treatment universally endorsed is this : that the grass, bushes, etc., which the hoppers are going to eat should be sprayed with a solution of arsenite of soda and sugar or treacle in water, the formula recommended being :—

Arsenite of soda	1 pound.
Sugar or treacle	2 to 4 pounds.
Water	16 gallons.

This solution is highly poisonous but its use is, in South Africa, unattended with any misadventure whatever ; fifty tons of arsenite of soda were used in one year with no cases of stock poisoning or poisoning of human beings. The report states definitely that if the solution is properly prepared and applied,

"it is very difficult for a beast or horse to acquire a noxious dose. Furthermore, fowls, pigs and horses have gorged themselves on the poisoned insects without ill effects." The poison is sprayed on with Knapsack sprayers, the hoppers eat the vegetation not only because they are hungry but because the treacle attracts them and they are poisoned wholesale.

The report contains also a chapter on the value of locusts as food and as a commercial product, but its chief interest lies in the fact that the above remedy is practically the only one on which they place any reliance. There are other and less valuable methods, *e.g.*, soap solution, mechanical methods, etc., but they are not fully endorsed. The legislation in force in Natal, recommended for general adoption, provides for the notification of "locust areas," the appointment of locust officers, who may serve notices upon land-owners calling upon them to carry out the destruction of locusts by specific methods, failing which the locust officer does it and recovers the cost from the land-owner. That is, every land-owner must destroy locust hoppers with arsenical solutions or Government does it at his expense; the Government assist by transporting all poisons free by rail, by lending sprayers and by giving warnings of locusts' swarms. In the Orange River Colony, bonuses are given for locusts destroyed, egg-laying and hatching must be notified and hoppers must be destroyed. In Cape Colony, Government gives aid with spraying material and machines; presumably the whole of South Africa will adopt the one remedy and the legislation in each colony will probably be the same.

The locusts of South Africa are distinct from those of India, and the conditions of agriculture naturally determine to a large extent the remedies to be adopted. Neither of the locusts is a desert locust such as is the North West locust of India; they are similar to the Bombay locust save in the important fact that they form swarms in the hopper stage, which the Bombay locust normally does not do. On the other hand, the sudden occurrence of large swarms is partly accounted for by the fact that the eggs do not hatch for years unless rain falls sufficiently; if in a

particular tract sufficient rain falls only after several years, there will be in that tract sufficient eggs accumulated to produce immense swarms and this apparently occurs. This is not known to occur with either of the Indian locusts.

It is perhaps needless to say that the remedy used in South Africa is not applicable to India where the conditions are so wholly different. In planning the Bombay locust campaign in 1903-4, the Natal remedy was kept in view and replaced by others. We have not in India the large stretches of veldt that can be safely poisoned without risk of injury to stock; 36 lbs. of their poisoned fodder will kill a calf, 72 lbs. will kill a bullock; were we to poison crops like this many cattle might die. The Transvaal in one year used 1,500 Knapsack spraying machines; there is not a half of this number in all India. Our two locusts also are totally different, and the administrative system in India is so perfected that the appointment of a vast staff of locust officers is entirely unnecessary even in the biggest outbreaks.

The report emphasises the value of dry locusts both as manure and as food for poultry, the latter specially. There is probably a very good market in India for dried locusts which are already an ingredient in curries, but we question if their value as poultry food is recognised by poultry keepers in India. Detailed directions are given by a poultry keeper as to the ration per fowl, varying from three ounces per week for breeding pens down to half an ounce for young chicks.—(H. M. Lefroy.)

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The Status of Apiculture in the United States. By E. L. Phillips (Bull. 75, part VI, U. S. Dept. of Agric., Bureau of Entomology).

In this bulletin, the author reviews the bee-keeping industry of the United States and the salient facts are of interest as showing to what a pitch of development this industry has been brought in the United States. It is of course impossible to contrast the industry in this country with that in America since there is no regular industry in India, but we may draw conclusions

applicable to this country from the industry as it exists now in the United States.

During the last fifty years the bee-keeping industry in the United States has developed from a small irregular one to an important and highly organised one; the bees used to be kept in box hives; the bar frame hive had not been invented, the methods of getting honey were wasteful and bee-keepers had no control over their stocks. The invention of the movable frame hive by Langstroth in 1851 gave an impetus to the industry and rendered possible the accurate study of the subject, the control of the bees and the gradual development of a large body of expert bee-keepers, with whom the industry is not the principal occupation, but is carried on with other business or in spare time after business is over. It is recognised that in no one place can a bee-keeper profitably work enough hives to give him constant employment but that there is scope for bee-keeping by a large number of persons as a cottage industry occupying only their spare time and it is in this way that the industry has developed naturally. At the same time the author deprecates a large number of very small bee-keepers (with five colonies or less) but advocates developing the industry by Apiarists owning more hives and taking greater care of them, specially as regards disease.

The value of the honey produced annually is put at about six crores of rupees (20,000,000 dollars) and the wax about a tenth of this (sixty lakhs of rupees or 2,000,000 dollars). The industry is thus no small one in its direct value and is a considerable asset in the wealth of the country. Actually about 12 per cent. of farms included bees in their stock in 1899, the value of these bees being put at three crores of rupees (10,000,000 dollars) and the average value per farm of the honey and wax produced is put at thirty rupees for that year.

In spite of this, the total imports of honey to the United States amount to two and half million pounds in 1908, of a value of three lakhs of rupees, and the imports of bees-wax to nearly seven hundred thousand pounds, of a value of five and-a-half

lakhs of rupees. There is, however, an export of honey and wax combined to the value of two lakhs of rupees in the same year.

The above figures give an idea of the magnitude of the industry and show that there is still room for development in the United States; but they show most clearly what a large amount of honey is consumed in the country and this is, to us, the most significant fact. What might not the consumption of honey be in India, where the present consumption of sugar is so large, if the honey were available: and it is to be borne in mind that the honey is there and is simply not available in an edible form, because bee-keeping as an industry is not practised. Apart from the direct value of the domesticated bee as a honey and wax producer, there is its indirect value in the pollenization of flowers. The author states that "the indirect benefit of the bee-keeping industry annually adds to the resources of the country considerably more than the amount received from the sale of honey and wax."

The author also discusses the sources of loss including the loss from swarming, winter losses, waste of wax, enemies, diseases and badly proportioned distribution of apiaries. When apiculture comes to be developed in India, these sources of loss will be worth considering; for the present we may point out that the very considerable winter losses would not, as a rule, occur in India, though others might. The author then discusses the needs of the industry, classing them as Scientific, Economic and Educational. All of these are likely to be met, the first by an extension of scientific investigation, the second by the general adoption of better methods by bee-keepers, the third by the action of the Bureau of Entomology in getting into touch with bee-keepers and *educating the public in the use of honey.* There would then be increased production and also increased use of honey as food by the people.

One salient fact the author emphasises is that what is wanted is the expert bee-keeper who is financially interested, who keeps a good number of colonies and who takes the work seriously, not necessarily as his main business but as an important

side-line. The small bee-keeper little interested in the subject, who keeps a few colonies badly, in the hope of getting a small yield but not a large profit, is a danger to the community because his hives are a source of disease infection. "Do it well or not at all" is the principle he insists on, that should guide the development of the industry.

The figures given above are worth consideration as regards this country. Honey as an article of food is limited to the hill forest areas of India, where wild honey is collected or where bees are kept in a state of semi-domestication in hollow logs or earthenware pots. As an article of general consumption it is almost unknown, though there are throughout India abundant wild bees which collect honey, and in some instances store large quantities of it. It is open to question whether pollenization is not already effected by such wild bees and whether on this ground the introduction of bee-keeping would have the same importance it has in the United States. But there can be no question that a valuable industry is being neglected, that there would be a very large consumption of honey were it available and that one of India's assets is wasted.

India is where America was sixty years ago; could India be in sixty years where America is now? Possibly, but certainly not until the value of bee-keeping is recognised and the industry is developed.—(H. M. Lefroy.)

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Sugar-cane treated from the manurial point of view by John Kenny, Director of Agriculture, Junaghad State. (Higginbotham & Co., Madras, 1909.)

Mr. John Kenny, Director of Agriculture, Junaghad State, has just published a pamphlet entitled "the sugar-cane treated from the manurial point of view."

After noticing the fact that five-eighths of the world's supply of sugar comes from the sugar-beet, which it might be possible to grow under suitable conditions in North India (Dr. Leather), the author points out that while the price of

sugar has declined, the cost of production by the old methods has remained the same.

In view of the present state of the indigo industry, sugar-cane is attracting the attention more and more of planters in Bengal and for this reason the paper under review may be of interest. Mr. Mollison and others have said that experiments at Government Farms have showed that sugar-cane might be produced more economically in India than in any other country in the world.

With reference to cattle manure, Mr. Kenny says: "Large quantities of it will contain a certain amount of salt which improves the growth of the cane wonderfully, but reduces the quantity of sugar contained in the juice. The Poona district growers should bear this in mind. Unfortunately for them the Government experiments have shown splendid growths of juicy cane by the use of enormous quantity of cowdung and poudrette, which was a waste of nitrogenous manure and certainly did not produce much sugar." To the latter part of this statement about the quantity of sugar produce, exception may be taken. In the Report on the Manjri experiments carried out from 1894 to 1903 we find that Farm Yard manure produced up to 11,000lbs. raw sugar per acre and poudrette produced even more, namely, 10,000 to 13,000lbs. per acre; surely, these amounts are up to the best yields of sugar obtained by most sugar-producing countries. If, however, Mr. Kenny means the quality of the juice produced is not good, in answer to this we may turn to an article on manuring sugar-cane by Dr. Leather which appears in the *Agricultural Journal of India*, Vol. I, Part 1. There we find on page 22 the statement that "In the Manjri experiments it appears probable that the largest amounts of manure used were unnecessarily large, probably half as much again as was necessary to produce the heaviest crops. But the cane did not suffer, the crops grew to great perfection and the *gur* was excellent." A case did occur in which an excessive amount of manure improved the quality of the juice, but Dr. Leather says of it, "it is an extreme case and naturally must not be taken to indicate that sugar-cane should not be liberally manured."

With reference to the application of the large dressings of organic manures given in experiments in India, Mr. Kenny says the result is not only a great waste of Nitrogen but an accumulation of salts which the sugar-cane, gross feeder that it is, takes up with the other plant-foods. The presence of these salts results in a watery juice, deficient in crystallizable matter. He also adds that the presence of reh or other salts in the soil has the same effect.

We find it stated that green manures are used in many parts of India, and it is recommended that phosphoric acid and potash manures be applied to the green manure crop.

Mr. Kenny states that no mention of trials with potash is made in the Government reports. However, in the Annual Report of the Department of Agriculture, Bombay, for 1907-8 we find the following: "Sulphate of ammonia seems to do better when added alone to cake and Farm Yard manure than when potash is also added. Sulphate of potash was found to have no value when applied with such heavy dressings of cake and Farm Yard manure." Also in the programme of work for 1908-9 of the Manjri sugar-cane experiment station we find provision is made for experiments with potash manures.

The following table taken from the pamphlet shows what a gross feeder the sugar-cane is. It gives the amount of plant-food in lbs. per acre removed by various crops.

Plant.	Nitrogen.	P_2O_5.	K_2O.	CaO.
Sugar-cane	127	44	298	71
Wheat	43	33	36	16
Barley	47	23	54	11
Maize	61	31	66	14
Rice	41	26	68	10
Potatoes	26	13	48	2
Cotton	54	19	40	25

Thus sugar-cane easily heads the list and it is especially noticeable how much more potash it removes than any other crop. Mr. Kenny adds if as should be the case the tops, leaves and thrashing of the canes and skimming and residues of the sugar house be returned to the soil, then the above figures for cane will be reduced considerably.

Manurial experiments in Java and Honolulu are quoted. In the former it is concluded that earthnut cakes give an immense return, but the juice is very poor, whilst small quantities of bone acid phosphates and potash show a very high return of sugar.

The Honolulu experiments show the most profitable combination of manures to be nitrogen plus potash which produced an increase of 9,922 lbs. sugar per acre over the unfertilised plot.

Experiments are quoted showing the great value of phosphoric acid and potash in Louisiana, Leeward Isles, Java and Hawaii.

Mr. Kenny states that the 'gul' obtained from the bone manure plots at Manjri was best of all, golden yellow in colour, with sparking crystals and firm as could be desired. It kept dry in the monsoon when 'gul' made from cane fertilised with poudrette and oil-cake manures generally gets pasty from the damp.

Mr. Kenny raises an interesting point when he mentions that in Hawaii as a question of economy it is proposed to apply all soluble fertilisers such as nitrate of soda in the irrigation waters.

He next devotes some pages to the manuring of sugar-cane in Egypt and discusses the effect of nitrogenous, phosphatic and potassic manures on the plant. Here we find recommended certain manures for cane in Egypt and the time and mode of application is stated.

On pages 27 and 28 Mr. Kenny hints at good results obtained by cultivators in India from the use of concentrated fertilisers, but he omits to mention what the fertilisers were.

Mr. Kenny quotes on page 29 a very interesting table of manurial experiments carried out at Poona under Prof. Knight. He says this table shows clearly the excellent results obtained from artificial fertilisers in a district where heavy manuring is ordinarily resorted to with good cattle manure. How are we to reconcile this with his former statement on page 5, among other scathing ones, about trials made by officials in the Bombay Agricultural Department that "as to potash we find no mention of it

in the Government Reports." In any case this is the first time that this fine series of experiments has been classed as "ridiculous." After mentioning the destruction caused by the borer moth, the author goes on to say that it is admitted by all sugar-cane planters that continued propagation from cuttings grown year after year in the same soil results in a serious degeneration.

As an explanation of the cause of disease which is produced when cane is grown continuously on the same land Mr. Kenny offers the theory which is coming to the fore lately that plants excrete from their roots substances which are detrimental to their own growth.

The whole object of the pamphlet seems to be to show that potash does not seem to have been given a fair trial in India. Since the function of potash in plants is to aid in building up carbohydrates such as sugar, starch, etc., it seems only reasonable to suppose that it will be of great benefit as a manure for sugar-cane.—(H. E. ANNETT.)

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A NOTE ON THE MANUFACTURE OF PURE SHELLAC, BY PURAN SINGH, F.C.S., ACTING FOREST CHEMIST. INDIAN FOREST MEMOIRS I, PART II, PP. 1—20.

IN this Memoir the author discusses a method of preparing pure shellac from the ordinary stick-lac produced in India. Lac, in whatever form, is valued by the trade precisely according to its colour; the lighter the colour, the more valuable the lac. This colour is dependent upon two things, the inherent colour of the lac-resin and the purity of the finished lac as regards the dye. The author fails to recognise this and attributes the whole question of price to the degree of absence of dye. Apart from this, the author is right in laying stress on the freedom of the lac from dye; it was apparently believed that lac from which the young had swarmed would contain no dye; anyone with practical knowledge of lac would know this is not so, and Phoongi Lac, or lac from which the young have swarmed, requires washing to free it from dye, just as any other lac does. It however contains

less dye. The Forest Department having proved this by chemical analysis, the author was led to try to obtain shellac, from Phoongi or other lacs, free of dye. This is done at present by washing and, though the author does not appear to know it, by the ordinary process of washing as practised in India, shellac can be obtained which is practically free of dye and it is constantly so obtained. Believing that lac cannot be freed of its dye by ordinary means and neglecting the inherent differences in colour of the various lacs, the author was led to believe that the pure lac-resins could be extracted by means of methyl-alcohol. He gives a description of various lacs, their chemical analyses, and describes the present methods of lac-refining and manufacture. He touches on the early methods tried for improving the manufacture of shellac but is not clear as to why they failed.

The author then discusses the waste in the present method of manufacture and his view that there is a large waste of irrecoverable resin during manufacture is one that should be impressed on every manufacturer of shellac. There is a great waste, and in these days, any saving in manufacture must be closely attended to. He then discusses the important question of the extraction of the resin by means of wood-spirit. Methyl-alcohol, which forms the bulk of wood-spirit, has the property of dissolving the lac-resins but not the dye; ethyl-alcohol dissolves the resins but also part of the dye. If the crude lac is then treated with wood-spirit, a solution of the valuable pure lac-resins should be obtained free of dye. Primarily the author has used this in the laboratory for the estimation of lac-resin and dye, but he believes that it can be applied in practice. He suggests that the lac be finely pulverised, after thorough drying, that the powder be exposed to the action of methyl-alcohol and that the solution of resin so formed be evaporated till pure shellac is left. He describes an apparatus in which he thinks that this operation can be carried on without waste of wood-spirit, the spirit from the evaporated solution being passed into the lac receptacle, condensed and used again to dissolve the resin. While giving many reasons why the process should be good, the author is

unable to say that it is practicable or how it is actually working out. How much wood-spirit is lost? What is the actual cost of producing shellac? Is it really possible to stretch the sheets of shellac and how are the sheets actually obtained? In practice we have found it extremely difficult to know when to stop the heating of the solution of shellac in spirit, *i.e.*, when it has really lost all its spirit and will set; how then is it to be obtained in sheets and stretched? We could mention many more practical difficulties, and it is a matter of regret that the process is as yet a purely theoretical laboratory one without practical application; the attention of the shellac trade has been drawn to this process; the trade is, at present, extremely depressed and any process of practical value might be of immense importance; it is to be hoped that the author will pursue his researches on a really practical scale and by showing the cost of producing shellac by this means enable the manufacturer to judge how far he can adopt it and whether he can really reduce the cost of separating the pure lac-resin from the crude lac. Even then, we doubt if the author is justified in talking about our being "enabled to meet the growing demand for shellac outside India." The present is a period of low prices, lower than for more than ten years and this because there is *not* an increasing demand. To the lac-grower as to the shellac-refiner, the times are hard and a cheap process will be of value; but a very great deal of practical work must be done before the proposed method can be anything more than a theoretical laboratory method, and if the author is desirous of benefiting the lac industry, he will carry on the work to the point of practical utility.—(H. M. Lefroy.)

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The Year Book of the Department of Agriculture, U. S. A., and the Annual Report of the Office of Experiment Stations, 1907.

These two volumes, just received, make interesting reading. The Secretary's report in the Year Book, extending to 138 pages, is a comprehensive review of the year's work. In spite of

unfavourable weather conditions, the year has been one of unequalled agricultural prosperity, the smaller crop yields being more than counterbalanced by their greater money value.

In Vol. III, Part I of the *Agricultural Journal of India* a rather full account was given of the activities of the Department and it is unnecessary to enlarge on these again. The work of the Department continues to expand at a great pace. The grant for Agriculture in 1907 amounted to \$ 10,118,451 (\$ 1 = Rs. 3 approximately) which was increased to \$ 12,210,156 for 1908. The number of people employed by the Department in 1907 was close on nine thousand, but it is necessary to remember that the U. S. Department of Agriculture includes the Forest service, the Bureau of Animal Industry, the Weather Bureau, the Bureau of Biological Survey and the Office of Public Roads. There were 64 Agricultural Colleges or institutions at which courses in Agriculture were given, and about 60 principal Experiment Stations.

The order of importance of the chief crops was maize, hay, cotton, wheat, oats, potatoes, barley, tobacco, sugar (including cane and beet), linseed, rye, rice, buckwheat, and hops. There is continuous effort to improve existing varieties by selection and by hybridisation, and at the same time the whole world is being explored for new crops and new varieties to suit the diversified conditions of the various States of the Union. The degree to which the maize crop has been improved in America for yield and quality of grain and for forage is well known. Early varieties of cotton are being produced in the South to escape the ravages of boll weevil. A practical apparatus has been devised for getting rid of light cotton seed, and it is claimed that the yield is thus raised 10 to 15 per cent. Wilt-resistant melons have been produced and attempts are being made to breed a rust-resistant asparagus. These are but examples of the work that is being done on all the principal crops. Among recent introductions of new crops or varieties, perhaps durum wheat has been most successful. First brought from Europe in 1899, the crop in 1907 was worth \$ 30,000,000. Mangoes imported from India within the last

few years are becoming very popular and the mango industry promises to be a big one. The beet sugar industry is another in which there has been phenomenal expansion, having increased from 6,000 tons in 1891 to 50,000 tons in 1907. Drought resistant alfalfas (varieties of Lucerne) and dry land rices recently discovered in China are expected to do well. A new variety of Soy bean has been discovered in the same country suitable for rotating with rice.

The Adams Act passed in 1906 promises to put the work at the Experiment Stations on a much higher plane than heretofore. The funds provided by this Act are only available for fundamental investigations, and nearly all the Stations have shown themselves only too anxious to undertake such work—in fact, a much larger number of investigations has been proposed than it will be possible to carry out satisfactorily. The great difficulty is the lack of sufficient men with the necessary scientific equipment and training for research. The Office of Experiment Stations occupies a very important position in advising on and co-ordinating the various projects. The discussion incident on the preparation of these projects has not only made clear the kind of work which can properly be undertaken under the Act, but has had the indirect effect of systematising the Station work generally.—(E. SHEARER.)